SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, APRIL 24, 1903.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE POTENCY OF ENGINEERING SCHOOLS AND THEIR IMPERFECTIONS.**

IT is natural at a time like this to revert in thought to the teaching of engineering in the technological schools of the country, and to ponder on the influence which this teaching produces upon their pupils and upon the economic welfare of the land. I have assumed that some consideration of this question will interest my audience today. A discussion of the potency in the body politic of engineering education is particularly appropriate before the school of applied science located under the inspiring heights of your majestic mountains, which afford an unrivaled richness to him who attacks their depths with efforts properly directed by science. Applied science gives you the power of reaching your ore, hoisting, treating and finally smelting it —applied science, which has been taught

* Address delivered before the School of Applied Science of the University of Colorado on November 14, 1902 on the occasion of the celebration of the quarter centennial anniversary of the University.

here and elsewhere to the chemists and engineers of your rugged state.

I am the more ready to discuss this theme here, in the inspiring presence of your mountains and their bracing atmosphere, because you have laid the foundation for, and have the opportunity to build up, a school of applied science (an engineering school) that may stand unexcelled amongst its eastern brethren. True, you are far from the centers of dense population; but the hum of industry is about, and great works are yet to be accomplished before the wealth of your state reaches its highest development; and the engineering school numbering 500 students may be as great as the school that numbers 1,500.

In the building up of your school of applied science, in this, your university, your people must remember that men and money are required. Men who are practiced, and, if possible, great, in two professions—the professions of engineering and of teaching. Money is requisite to pay for the services of these men, and much money for the equipment of laboratories in which they may adequately teach their students—the sons of your state and of its neighbors. In following my remarks, please remember that I bear no mission of instruction to this university; but I make a plea and explanation to those not technically informed friends of the university who may not fully understand, and who desire to know, whence spring the peculiar advantages of technological education and those requirements which demand particularly large expenditures in its adequate support.

During the course of two decades, we as a people have rapidly advanced toward an appreciation of the proper relations of the engineer to his surroundings. The true conception of engineering may be accepted as comprised within the good old definition, 'Engineering is directing the sources of power' (and wealth) 'in nature to the use and convenience of man.' The man who with fullest success follows the profession defined by this keenly conceived sentence must be a man of science, a man of the world, a man of business, and a man who is well acquainted with the trend of human civilization and human aspirations. To make such a man requires the highest thought and effort of the best teaching influences. Michael Faraday (one of the magnificent men whose lives have been dedicated to the commands of pure science) said that it requires twenty years to make a man in physical science, the intervening period being one of infancy. How much more effort must be carefully expended to make a man not only in physical science, but also a man in business and a man in sociology, all in one! Such men are all of the great engineers, measured according to their times; and to them ought to be accorded in their youth the most careful training.

Our engineering college men at their graduation should properly be looked upon as apprentices in the engineering profession. The student must be inspired in college and taught to work for himself in the manner adopted by George Stephenson, when instructing his assistants and pupils. 'Learn for yourselves,' said he, 'think for yourselves, make yourselves masters of principles, persevere, be industrious, and there is then no fear of your success.' The students should be become *thinkers* in college, capable of usefully applying their scientific knowledge therein obtained; and they should be expected to become thorough engineers through experience in applying this knowledge in a manner which may only be gained in an apprenticeship in the industries, similar to the office and hospital apprenticeships of rising young lawyers and doctors.

The methods used at West Point and Annapolis in training officers for the army and navy, and the course of the graduates after leaving those academies, fairly illustrate my point. It is there held that "a man, to know how to teach another man to pull a stroke oar, must get on the stroke oar himself; to be safe as a quarter-deck officer, to give orders for reefing a topsail in a gale of wind, he must himself have reefed a topsail in a wind. To know how to tell a man to ease a weather sheet or to work the gear of any part of a ship, he must have had his practical experience on that same gear. He can not instruct his men properly, he can not command them safely and efficiently, unless he has been through three or four years of hard practical experience, hand in hand with the men in the forecastle. The same thing is true of engineering. No man is fitted to be superintendent (or manager) of a road or works, no man is capable of carrying on large engineering operations until he has had the practical experience which fits him to pass judgment upon what will be the result of the directions which he may give to others."

Four years is but a small part of Faraday's period required 'to make a man' in the physical sciences, and in so short a period (which is the duration of the engineering college course) only the foundations of the engineer (the *man* in science, business and sociology) can be laid. "There is a great difference between reading and study; or between the indolent reception of knowledge without labor, and that effort of mind which is always necessary in order to secure an important truth and make it fully our own," said Joseph Henry; and the engineering college course should be bent toward such a complete and true presentation of thorough science and truth that the student is incited permanently to secure it for himself and make it fully his own—and he may then put it to valuable use in future practice. "It is not enough to join learning and knowledge to the mind; it should be incorporated into it."

The engineering college graduate should be a fertile and an exact thinker, and a man of value upon his graduation; but he can not come to his highest fruition until years thereafter. The speaker would gladly be judged of the success of his teaching by the success attained by his students after years of practice in their profession, but let no judgment be passed (as is so often done in some colleges) upon the basis of wages received during the year after graduation. Our engineering college teaching may be properly condemned if it does not plant those methods of thought which will grow more valuable with the years, and, indeed, become most valuable only after the mature development of the individual.

The engineering course should not be too formal or limited to the expository methods used of old in instruction in classics. Professor Tait speaks the views of the scientist when he says: "It is better to have a rough climb (even cutting one's steps here and there) than to ascend the dreary monotony of a marble staircase or a well-made ladder. Royal roads to knowledge reach only the particular locality aimed at, and there are no views by the way. *It is not on them that pioneers are trained for the exploration of unknown regions.*" The truth of this proposition has been discovered of late years by even the most ardent classicists, and those of us who are called upon to teach men in every one of whom must be developed a certain spirit and power 'for the exploration of unknown regions'—we who meet this unique problem, untrammeled by traditions and strongly aided by the influence and examples of the old engineers, should most fully appreciate and adopt

this precept of a great mathematician and philosopher.

To the engineering student in college the laboratory is of inestimable value. In it he can learn the true relations between science pure and science applied. He can learn to reason true, from cause to effect. His mind may be developed less trammeled than in the class-room, and the inspiration to independent thought may be more readily given deep root. 'Every branch of engineering is becoming more firmly rooted to the scientific bed rock upon which it rests,' and the engineer must be a man of scientific methods, besides being a man of business. He must have learned with the scientist that the price of success is constant, concentrated effort. All this can be taught better in the laboratory than in the class-room. A spirit of indifference which may be readily bred in the class-room, and which is ruinous to success and happiness in life, can not exist in the laboratory that is properly administered. "Genius is nine parts character. The prize is to him who dares, not merely to him who can." *In the laboratory the student may be inspired to dare.*

It must not be thought that I do not give adequate place to the class-room lecture and the text-book recitation. The laboratory work should be carried on in unison with and fortify the work of the class-room. A power may be had through it which can not be gained in the more formal meetings, and I would have at least one half of the time allotted by students to the study of applied science spent in properly supervised laboratories.

The subjects taught are not of so much importance as the effect to be gained in the students' powers, but certain branches lend themselves particularly to the desired end and admirable laboratory equipments in those branches are essential to every fully successful school of engineering. Here the budget of the university is affected. It requires large sums of money to equip, maintain and administer such teaching laboratories, and only few (very few) of the greater engineering schools have yet approached a satisfactory point therein. In this state of great mineral wealth, that has been, and is still more largely being, developed through the knowledge of the engineer, it is reasonable to hope that some public-spirited citizen of ample means will adequately endow the engineering laboratories of this, the university of his own state, so that they may take and hold due rank with the best.

But some of you may say, "What is the benefit to the body politic of the expensive laboratories in our midst? We admit the benefit to the students who personally enjoy their advantages, but is their effect more far reaching?" Most assuredly their effect *is* more far reaching—it reaches to the uttermost limits of the industrial progress and prosperity of the land. In this nation the industrial pursuits are engineering pursuits, and each betterment of clear perception amongst the engineers goes to strengthen the roots of our whole national life. He who truly ponders the question of modern civilization can not but admit that its best and kindest features rest immediately upon the foundations of scientific discovery and invention, and that the engineers and their works constitute the most mighty human force now moving society. Let us think of a few of the engineering feats of the century gone by:

George Stephenson, in 1829, after painfully developing the locomotive, won the Rainhill contest, and the preeminence of steam locomotion over draft animals was established before the world. Here was the christening of that civilization which rests upon the ready communication between the people.

Joseph Henry, engineer by nature and education, scientist of renown, perfected the electromagnet, adapted it for signalling purposes, and taught the world how to operate it at a distance. The fruits of this single application of electromagnetism, brought to commercial perfection through the efforts of the then derided Morse and the brilliant Graham Bell, have twice revolutionized the commerce of the world and incalculably advanced its civilization.

Through the brilliant and daring Ericsson, one of those mighty acts of Providence that sometimes occur in the guise of miracles was wrought in Hampton Roads for the preservation of independence and liberty amongst the race.

These examples from the last century are sufficient to serve my purpose of illustration. The progress of the new century bids fair to magnificently exceed the past.

The engineers of the world may be thought of in connection with three classes:

The scientific followers after principles and inventions.

The plodding constructors and originators of structures.

The engineering plungers and promoters.

The first are to-day by far the greatest, and their preeminence grows with each application of new discoveries to the use and convenience of man. But we must not fail to give proper honor to the faithful workers of the second class, who founded the profession and are yet its mainstay; or to lend due admiration to the brilliancy and daring of the third class.

In the first class are found such names as Rankine, Lord Kelvin, Werner Siemens, John Hopkinson and Joseph Henry, to whom I have referred. In the second class stand Telford, Stephenson, Gramme, Corliss and many others of renown; while James Watt stands as a link between them and the first. The third class lists such men as the admiration-compelling Ericsson, Bessemer, Holly and Morse.

These men, who have so largely contributed their part of blood to the living strength of the industries, whom I have selected to represent the past in engineering, are giants in beneficent influence upon the growth of civilization and the development of the wealth of the world. Their lives will be felt until the name of the nineteenth century is blotted from the memory of man. Each has played his part. The industry-promoting Bessemers more immediately increase the wealth of the world; the steady Telfords and Stephensons contribute much to its permanent comfort and convenience; but the scientific discoverers of principles and engineering inventions appear to lend the most far-reaching influence to the world and its civilization. Let us see what foundation of knowledge now exists upon which such men may base their work.

With all the effort of the centuries since the days of Gilbert and of Bacon, when the validity of experimentally proving natural laws was firmly established, we have really advanced but little towards the heart of nature's secrets. The material progress of the world depends largely upon improvements in our methods of utilizing what we now think of as three factors:

1. The properties of material matter.
2. The characteristics of energy.
3. The characteristics of intellect as found in organic life.

We are yet profoundly ignorant of the ultimate character of either matter, energy or life. Experiments seem to indicate that we may find the clue to the mystery of the first two, but it is yet impossible to assert whether, in our present state, we may reach an entire understanding of their true character. Experimental investigations often become increasingly difficult as we approach the goal of ultimate truth, and the

final attempt to press into the citadel of a cardinal truth may cost more effort than all of the approach through the outer works.

However, we have gained a store of knowledge about materials, energy and organic life, and have organized it in such a way that it seems to point to a few great, generalized facts. We apparently have learned that nature is never idle, but that she is a persistent worker with a steady, cumulative activity in which there is ever a unity and no discontinuity; that there is an ever-present 'dovetailedness' as Dickens, I think, put it. Nature's activities are not isolated and independent of each other, but are apparently all in intimate relation, and governed by the same all-pervading fundamental laws. This is the foundation on which the engineers of the present century have to work. Meager as it is, it is far in advance of that occupied by their predecessors of one century ago.

Of fundamental laws we seem to have proved two—the law of the conservation of energy, as it is called, and the law of organic evolution, which controls the development of life through the 'survival of the fittest.' I spoke of these as proved, and so they have been as far as they relate to the problems of our daily life; but they have been rather deduced by inference, as far as the universe at large is concerned, than established by demonstrations. The law of evolution has been so widely discussed in type and speech, that I may assume on the part of each of you some knowledge of its doctrine, and I will at once pass on.

The law of conservation of energy asserts that energy can not be created nor destroyed. We may transform energy in any manner within the compass of our intellect, but we finish with the same amount of energy as we started with. We may transform the chemical energy of coal, by combustion in a boiler furnace, into heat energy, and this may be utilized to 'raise steam.' The energy in the steam may be transformed into mechanical energy by means of a steam-engine, and this into electrical energy by a dynamo. The electrical energy will be less than the original chemical energy because some of the heat has gone to contribute warmth to the surrounding air and solid bodies, but the available electrical energy added to all of this heat (which has not been destroyed, mind you, but continues to exist as heat) *makes a sum which exactly equals the original chemical energy in the coal.*

Another fundamental law has been ordinarily accepted as governing; this relates to matter. You all know that matter is apparently indestructible. Transform it as we may; change, by combination, the matter which we call hydrogen and that which we call oxygen into that which we call water; again, combine this with metallic sodium to form caustic soda; again, form other combinations or compounds—through them all we have apparently transformed matter without gain or loss, and hold the same mass at the end of our transformations as we held at the beginning. The chemists have been making a very thorough study of this idea for years past, and they do not seem convinced that it represents a universally applicable law; but for all present purposes of the engineer it may be safely accepted.

In accordance with these laws relating to matter, energy and life, and their myriad corollaries, the professional engineer must carry on his work through the discovery of scientific principles and their useful combinations. Invention is no longer a mere question of designing a working machine. That may now be safely left to the skilled mechanic; while the engineering inventor must discover new combinations of scientific principles and

give them applications that are useful to man, in order that they may more perfectly contribute to the support of the race. Men must be educated for this purpose in our schools of applied science. This education can not be efficiently gained without the help of the schools.

Again, new principles must be discovered and great laws deduced, and contributions must be levied from them for the support and advancement of the race. It has long and justly been regarded a signal achievement to discover an important phenomenon or principle in science, and the discoverer has been stamped a learned and great man. It is still a signal achievement to discover, but the discoverer may add luster to his fame in our time by directing the application of his discovery to the service of mankind, so that no undue delay may be suffered to occur before it too contributes to the welfare of civilization. These men also may be most effectively educated in our schools of applied science.

The motive force of progress and civilization at the opening of the twentieth century is infinitely greater than at the opening of the nineteenth; largely due to discoveries and the world's slight education in science; and the possibilities following great discoveries are equally increased. Carrying this education of the people in applied science to its farthest limit must accentuate the progress, bringing with it those trains of good that follow in the wake of broader intelligence and wider opportunities. Every industry, every line of transportation or system of intercommunication, every branch of useful endeavor, has profited by the growth of scientific teaching and the work of the engineering schools; and civilization, which spreads, fattens and grows great through transportation and intercommunication between peoples, has been the gainer. Manifestly the influence of the schools of applied science is vastly greater than the effect directly produced on their individual students.

Consider the growth of our own people! The nineteenth century opened while the meridian crossing the center of our population bathed half its length in the Atlantic Ocean. Now it approaches its baptism in the Mississippi. The opening of our fertile domains, of which this tells the tale, is a story of transportation and intercommunication—the steam railroad and the electromagnetic telegraph, applied science allied with vigilant energy.

Much was formerly preached of a discord between theory and practice in engineering, and the old specter has not yet been laid for some. But no such discord ever existed except in the minds of the unlearned who failed to see that it was the finger of truth which washed away their rule of thumb; and with even them it existed only as the suspicion arising, as Bacon says, 'of little knowledge.' Even this phantom was laid in 1855 through an admirable address by the learned engineer, Professor Rankine, whose discoveries added much to engineering practice, and whose early death was so deeply mourned. After tracing the development of meager scientific knowledge and mechanical practice amongst the ancients, Professor Rankine makes the following observations:

"As a systematically avowed doctrine, there can be no doubt that the fallacy of a discrepancy between rational and practical mechanics came long ago to an end; and that every well-informed and sane man, expressing a deliberate opinion upon the mutual relations of those two branches of science, would at once admit that they agree in their principles, and assist each other's progress, and that such distinction as exists between them arises from the difference of the *purposes* to which the same body of principles is applied.

"If this doctrine had as strong influence," continues Rankine, "over the actions of men as it now has over their reasonings, it would have been unnecessary for me to describe so fully as I have done the great scientific fallacy of the ancients. I might, in fact, have passed it over in silence, as dead and forgotten; but, unfortunately, that discrepancy between theory and practice, which in sound physical and mechanical science is a delusion, has a real existence in the mind of men; and that fallacy, though rejected by their judgments, continues to exert an influence over their acts. Therefore it is that I have endeavored to trace the prejudice and practice, especially in mechanics, to its origin; *and to show that it is the ghost of a defunct fallacy of the ancient Greeks and of the mediæval schoolmen.*"

Enough has been said to illustrate my point. The influence of schools of applied science is vast and far-reaching, and every dollar spent in the establishment and maintenance of well-considered schools not only returns abundantly to the states in which the schools are centered, but their usefulness may extend to the nation and the world at large. Patriotism now needs no better object than the founding of such schools.

We may now justly turn to enquire into the character of the education for the individual that may be derived from such schools. Herbert Spencer names in a sentence the true criterion by which to judge of the adequacy of an educational process, and I can not refrain from a quotation: "To prepare us for complete living," says he, "is the function which education has to discharge; and the only rational mode of judging of any educational course is to judge in what degree it discharges such function."

Here arises the query, What is complete living? Spencer answers this, but we may each likewise answer for himself out of his personal consciousness and experience: An education for complete living includes training the faculties of self-preservation, the faculties of self-support, the faculties of proper parentage, the faculties of proper citizenship, including the betterment of our political and social relations, the faculties of properly enjoying one's leisure and lending enjoyment to others. Education, to use the words of Huxley, 'ought to be directed to the making of men,' and must include 'things and their forces, but (also) men and their ways.' We can not, we must not, cultivate one to the exclusion of the other.

The study of science and its applications, in the atmosphere of our better engineering schools, certainly lends largely to each of the faculties and powers which are required for complete living. It has been asserted that it lends more immediately to the earlier and less disinterested ones; but this assertion I must deny. The profession of the engineer demands a creative imagination cultivated to the sober, clear sight which sees things as they are; and a quick appreciation of the effect of sentences and their combinations; which make him akin to the creators of art and literature, and give him in large degree the more disinterested faculties named. I am willing to yield to no one in an appreciation of art, literature and music as an element of the highest importance in the education which goes to relieve the strain of an overarduous professional existence and to smooth the relations between fellow men; and I can not but regret that these liberal branches must be omitted from the curricula of the engineering schools. But I also can not fail to remember that an education in applied science brings keenness of perception, and recognition of truth and

beauty, to its average followers, from which springs an appreciation of art and literature and music which rivals that produced in the most gifted product of the literary colleges. "With wisdom and uprightness a nation can make its way worthily, and beauty will follow in the footsteps of the two, even if she be not specially invited."

Of all the intellectual faculties which we cultivate through education, the most useful is the faculty of sound and mature judgment; and of all, this is the one most often deficient. Here the laboratories of applied science are strong in their influence for good. That man who follows the laboratory courses in one of our well-administered engineering colleges and goes forth without improvement in his faculty of judgment and a quickening of his executive powers is an unworthy son of man. The force of straight thinking can not be over-estimated. 'Victory is for the people who see things as they are without illusion, who do not take phrases for facts,' and straight thinking is one of the gifts derived from the engineering laboratories. The engineer's duties require that he shall possess this most important of mental attributes; and fortunate it is for the profession, for it makes of every great engineer a man of greatness. Do you question this statement? If you but enquire of the past you will find it proved. Amongst no class of men is found a broader sympathy with humanity and a more liberal view of the progress of the race than is exampled in the lives and works of the great engineers, and none have been better or nobler citizens.

Yet, withal, it must be a matter of concern in the technological schools lest the lines be drawn too close, and the students become absorbed in an ungenerous, over-earnest pursuit of details. Breadth of view may be sacrificed unless our teachers be men of ripeness and power, and the students learn through them that each element in the life of the 'complete liver' has of itself an intrinsic merit. This fear of a belittled outlook for some of our students, whose ambitions or mental aspirations may have never been stirred in their pre-college days, would be dissipated could the personality of each teacher in the schools of applied science include that rare combination of mellow scholarship, clear scientific perceptions and engineering common sense which we occasionally meet and which a few colleges rejoice to retain in their midst.

The teaching force of an engineering school should ideally be made up of engineers—men who have seen some years of successful practice (and preferably continue to hold some practice), who are held in esteem for such by their brethren in practice; but who have a joy in the quiet life of the scholar which is traditionally associated with the colleges, and who may thus be contented when outside of the immediate tide of engineering production. Yet the teaching of engineering is a question of pedagogy rather than of the engineering profession, and it must be dealt with with this clearly in view. Here is one source of many profound imperfections in our existing schools. I venture to say that it is the exception rather than the rule when a teacher in a school of applied science has given any consideration to the tenets of psychology and pedagogy, upon the due application of which depends much of his success in properly impressing his students. These teachers are doubtless no greater offenders than their brethren in the so-called colleges of liberal arts, but in this is found no palliation for the offense. Fortunately, a goodly proportion of the older ones amongst the devoted men who are contributing their blood and brains to the welfare of the

engineering schools are often endowed with a natural sense of fitness in the processes of education, and the younger gain due appreciation of methods from association with them. Yet I must regret to say that proposals relating to the curricula of the technological schools are frequently offered, which unpardonably violate every tenet of good teaching.

This condition ought not to exist, and it can not continue after the truth has seized hold: that these schools are facing a teacher's problem, which must, indeed, be met by engineers with all of the directness and power of the engineer's best efforts—but that the problem can not be solved as one solely relating to the engineering profession.

It is sometimes thought that men who can not make a success in business life are just right for teaching. This is entirely wrong, and the idea should not be admitted for a moment in any modern technological school. The discontented man who has made a failure in business life will certainly make a failure in teaching engineering. Engineering colleges should avoid 'men who are fools in working,' even though they are 'philosophers in speaking.' Enthusiastic men are wanted; they may be young men, if needs be, but they must be paid well enough so that they may take places as self-respecting members of the engineering profession, and they must be properly chosen with respect to their qualifications. These men must be good professional engineers; they must possess power and satisfaction gained from engineering research, and from attainments in other lines than those of purely professional acquirement; but sound teaching is their work of first importance. It is very difficult to teach well, but that is no excuse for admitting poor teaching into the engineering schools.

The problem in the engineering colleges is rendered more complex by the character of the curricula, which require that the students shall follow for a period what may be denominated preparatory science instruction before they enter upon the truly professional work. In the latter, at least, the teaching should be largely by inspiration and suggestion.

The process of gathering, organizing and assimilating knowledge by each student should, as Spencer suggests, be as far as possible a process of self-evolution. If a professional student will not follow his work with zest and satisfaction, it is a thankless and doubtful task to force him to it. The best method for the teacher in professional subjects (but the method of all methods difficult to follow without abuse) is indicated in Kipling's verse:

> "For they taught us common sense,—
> Tried to teach us common sense—
> Truth, and God's Own Common Sense
> Which is more than knowledge.
> * * * * * *
> "This we learned from famous men
> Knowing not we learned."

The engineering colleges are at fault in not more fully developing the initiative, the enterprise and the executive powers of their students, though this is a difficult part of the task of 'making a man.' But that thing must be done in order to make successful industrial engineers. It can be done largely by influence, by the character of the treatment of the students, and by the sort of ambitions that are put into them. It can be done in some degree by the selection of the work assigned to the curriculum, but the subjects studied are of less importance than that the students learn,

> "Truth, and God's Own Common Sense."

The teacher must remember when he tries to teach by inspiration, even though his time and method be wisely chosen, that he may expect to receive in the class-room

some hard blows to his self-regard and his esteem for his teaching. He may pour stimulating thoughts over his students day after day for weeks, and finally find that few have taken root. He may even be brought to that state of desperate depression that is illustrated in one of Turgeniev's novels when its hero, Dmitri Rudin, failed to succeed in his post at the university. The engineering teacher—provided he is sure of his time and method—may take heart by remembering this: that if every stimulating thought presented to his students, whether relating to professional applications of theoretical principles or directly to the development of initiative, self-reliance and executive powers—if every stimulating thought took root in every student's mind, those minds would become over-burdened cyclone centers of thought; and if one real thought takes root from time to time in each student's mind the teacher may be truly satisfied.

I have already suggested that the question of professional instruction in the engineering schools is entangled with the problem of leading the students through a course of preparatory science looking towards the professional studies. The medical schools may and largely do escape this responsibility by requiring their students to pursue a liberal college course before embracing the professional courses. The existing plan of the medical schools is ill-advised when viewed from the engineer's standpoint, but we hope that some inviting plan may yet result from the proposals made by several great university presidents in respect to coordinating the liberal and professional college courses. We would gladly welcome the old-time college course and the old-time preparatory course, especially as far as they made men of vigorous thought who could spell and cipher; and we now gladly receive and encourage all students who have been willing and able to complete an academic college course before entering upon their technological studies.

Broadly, however, until there arises such an advantageous plan of coordination which may be adopted with advantage to our students and to the profession, the engineering schools will continue, as heretofore, to instruct their students for four years immediately following the high-school course—the first two years being largely filled with mathematics, chemistry, modern languages, drawing and other subjects leading to the professional studies of the engineer. These students come freely to the college at an age between seventeen and twenty, equally immature in mind and body—and one part must not be trained at the sacrifice of the other. "It is not sufficient to make his mind strong; his muscles must also be strengthened; the mind is over-borne if it be not seconded."

Montaigne puts it very gracefully: "It is not a mind, it is not a body which we erect, but it is a man, and we must not make two parts of him." A prime requisite to success in life 'is to be a good animal,' and the engineering schools must look after the bodily and social welfare of these entering students in a way that is not required of the medical school with its course largely recruited from the liberal college. These students should be encouraged to enter into the various interests of the life around them, especially of the college life, including its social affairs and its athletics and gymnastics. The extra responsibility which thus rests upon the teacher in the engineering schools equally increases the effect of the influence with which his personality affects his students. The latter is a recompense that every lover of teaching will willingly make sacrifices to obtain.

My discussion of my subject has been brief, though, perhaps, as long as your desire. I have tried to show you that the wide influence of the engineering schools is of two branches: First, a direct effect exerted through the graduates extending the useful applications of science to the advantage of man (which is the effort of every true engineer); second, an indirect (but equally important) effect resulting from the admirable education disseminated amongst the people. And I have pointed out not only elements of great educational strength, but also some sources of weakness in the schools. It has been my particular wish to bring to your mind some image of the potent influence for good which has been in the past, and still more may be in the future, borne on the body politic by these schools, and to impress you with the desirability of bringing to their support the same bountiful endowments that are now justly flowing to the support of the medical schools. I trust that I may have interested you and that I may have reached, in some degree at least, my object.

In the course of my remarks I have had frequent occasion to use the phrase 'applied science.' You must not mistake me. Applied science is not something set off by itself and differing from 'pure science,' so-called. Far from it. It is pure science, if you wish, pursued in the stimulating, nutrient atmosphere bred of the belief that all scientific knowledge returns to its possessor great good in proportion to the advantages which he, through it, brings to mankind. Such an atmosphere is to be found in many of our medical schools and, I hope, equally in our engineering schools.

DUGALD C. JACKSON.

UNIVERSITY OF WISCONSIN.

STAMENS AND PISTILS ARE SEXUAL ORGANS.*

THE statement in the above title will be received by some of my hearers with wonder that so obvious a matter should need any discussion, while by others, especially those versed in the modern morphology, it will be met by emphatic dissent. Yet I am convinced of its truth, and venture here to rise in its defense.

The discussion of the subject is not new. Professor L. H. Bailey, in SCIENCE for June 5, 1896 (reprinted in his 'Survival of the Unlike,' page 67), defended, with his usual clearness and vigor, the application of the sex-terminology to stamens and pistils; and he was answered in the same journal for June 26 by Professor Barnes, who maintained the strictly morphological view that the sex-terminology should be restricted to the gametophytes, or so-called sexual generations, within the pollen grain and the embryo sac of the ovule. Recently this morphological view has again been emphasized by Professor Ramaley, in SCIENCE for June 20, 1902, and he puts the case in its extreme logical form when he says: "The stamens, therefore, can not be male organs, nor the carpels female organs. * * * There are no such things as male and female flowers, nor flowers which are unisexual or hermaphrodite." This view I hold to be an error, for the reasons which follow.

To prevent misunderstanding it should be said at the outset that there is no difference of opinion as to the morphological facts involved. We all agree that the contents of the embryo sac when it is ready for fertilization, and of the pollen grain when in the corresponding condition, are the gametophytes, the precise morphological equivalents of the prothallus or sexual

* Read before the Society for Plant Morphology and Physiology at the Washington Meeting, December 30, 1902.

generation (gametophyte) in the pteridophytes. Where I differ from the extreme morphological view is just here, that while I admit that all sexuality, in whatsoever that may consist, is confined to the gametophyte in the lower forms where the two generations (as best manifested in the ferns) are structurally, morphologically and physiologically distinct, I deny that sexuality is confined to the gametophyte in the higher plants, where the gametophyte has become structurally incorporated with, and physiologically dependent upon, the sporophyte. If, then, sexuality is not confined to the gametophyte of the flowering plant in fact, obviously it should not be in terminology.

We must here note an important point in the discussion, namely, that it has two distinct phases: (1) There is the matter on which Professor Bailey argues, that, as a matter of propriety in usage, the old and familiar sex-terminology should not be wrested from its prior and consistent analogical significance and given a new and technically limited morphological application. (2) There is the new contention here defended, that a restriction of the sex-terminology to the gametophyte in the flowering plant is incorrect in fact. We may best consider them separately.

As to the first, and allowing for the moment (for clearness of argument) that sexuality may be confined to the gametophytes in the flowering plant, I think Professor Bailey's argument for the retention of the sex terminology to its present application is perfectly conclusive. He is certainly correct in his contention that the original sex-terminology was based upon analogies, with no thought of homologies; a male organ was that structure which secured the formation and functioning of the male element, and such an organ a stamen is; a female organ was that structure which secured the formation and functioning of the female element, and such an organ a pistil is. Now morphologists have no right, I believe, to attempt to wrest the sex-terminology from its consistent, intelligible, widely-used and *prior* application to analogies, and give to it a new and technical use for homologies, an attempt made still less excusable through the claim of its advocates that the earlier application is erroneous and only theirs is correct! Science is expected to apply new terms to its discoveries, and new conceptions; it should not attempt to appropriate an older terminology to new uses. As a matter of fact science *has* given an ample terminology of its own to the parts of the plant involved in the present discussion, and the confusion which has arisen in teaching and elsewhere is the result of a neglect to make full use of those terms, a neglect due no doubt to the mistaken notion that an adaptation of the older terminology to the new conceptions would conduce to clearness. I am of opinion, based upon some experience, that the difficulties in teaching, of which Professor Barnes and Professor Ramaley speak, can be met by a rigid application of the definite scientific terms *sporophyte* and *gametophyte,* with an abandonment of the misleading terms *sexual* and *non-sexual generations.*

We consider next the second point, whether, as a matter of fact, sexuality is confined to the gametophyte in the flowering plant. At the one extreme is the gametophyte of the fern, independent anatomically, morphologically and physiologically from the sporophyte; to it the name sexual generation (viz., that generation which produces the sexual elements) correctly and appropriately applies. At the other extreme is the gametophyte of the specialized phanerogam, where the gametophyte is formed, nourished and de-

veloped entirely within the tissue of the sporophyte, in the most intimate anatomical and physiological contact and dependence upon the latter, and is quite incapable of developing the sex cells without the direct cooperation of the sporophyte. It is plain that a part at least of the work of nourishing and preparing the sex cells for their functions, assumed by the prothallus in the fern, has in the phanerogam been transferred from the rudimentary prothallium to the highly developed sporophyte. The morphological line between gametophyte and sporophyte can still be traced (though only through recondite comparative researches), but the physiological, and to a great extent the structural, line between the two has vanished. The gametophyte, therefore, does not constitute a 'generation' in the sense in which the word was originally used in the ferns, for the physiological equivalent of the sexual generation of the ferns is, in the phanerogam, the gametophyte plus part of the sporophyte.* Not only are the tissues of the sporophyte in the immediate vicinity of the gametophyte specialized to aid the latter in its work of developing the sex cells, but this is true (though to a lesser extent) of the sporophyte tissue for long distances away, even to the confines of the parts we call stamens and pistils, so that I can not doubt that some at least of the attributes properly belonging to a 'sexual generation' have been transferred that far back from the gametophyte into the sporophyte. It is no objection to this view that I can not tell where in the ascending series the 'sexuality' begins to pass over to the sporophyte; even if we knew precisely the actual stages in the evolution from fern to phanerogam (which we do not), and even if we were agreed upon a definition of sexuality (which we are not), it might still be impossible to tell precisely, so subtle are the gradations of natural processes, and so regardless are they of definable categories.

* The intimate physiological interlocking of gametophyte and sporophyte is strikingly illustrated in the phenomena of polyembryony, where the sporophyte (nucellus) has acquired the power of producing embryos within the embryo sac, which embryos, although purely asexual, have the general form and course of development of embryos produced by the gametophyte. The physiological equivalence of perisperm and endosperm points in the same direction.

The sum of my argument, then, is this —that in the phanerogams the physiological line between the two 'generations' has vanished, and that a large part of the original function and attributes of the gametophyte has been transferred to the sporophyte which has had its tissues specialized to that end; hence the gametophyte of the phanerogams is no longer a 'sexual generation' in point of physiological fact, and it is misleading to use the name as an expression of morphological relations; sex not being confined to the gametophyte, the sex terminology can not be.

Only the morphological line remains to mark off the two generations in the phanerogam, but it is precisely this fact which has caused the whole difficulty. Morphologists have found so great a satisfaction in tracing the intricate but beautiful homologies from fern to phanerogam, that their attention has become centered exclusively upon the morphological phases of the subject, to the exclusion of its physiological aspects. They have forgotten that sexuality is more a matter of physiology than of morphology, and that function cuts across morphological boundaries in the most irrelevant manner. They have fallen into that error, against which Goebel has so forcibly warned us, of attempting to interpret morphology without reference to function, a method which can lead only to

a sterile formalism quite unrepresentative of nature's unconventional methods. That they have in this case fallen into this pit is due, I think, to the misleading influence of words. Starting with forms in which there are two distinct generations (as in the ferns), and applying very appropriately the terms *sexual generation* to the gametophyte and *non-sexual* to the sporophyte, they have kept these names for the morphologically equivalent stages in the evolution to the phanerogam, not noticing the gradual emptying of the names of their original physiological significance; until, finally, the names themselves have come to stand in their minds for the facts they state, and to be accepted as evidence, or even as final authority, upon the points at issue. The mischievous terms *sexual* and *non-sexual generations* have been and are the cause of the whole difficulty. Let us abandon them.

W. F. GANONG.

SMITH COLLEGE.

A TROPICAL MARINE LABORATORY FOR RESEARCH?

DESPITE the creditable activity which has developed in our country in biological research during the past few years, it must be confessed that it is difficult to explain the neglect upon the part of our naturalists to avail themselves of the opportunity to study the marine life of the tropical Atlantic, especially as one of the most, if not the most, favorable locality for the prosecution of such researches lies within our own territory at the Tortugas, Florida.

As Professor Davenport aptly states, we know more of the life of the Red Sea than we do of that of the Caribbean and Gulf of Mexico.

Our knowledge of the life of the tropical Atlantic is almost wholly dependent upon the results of brief and cursory expeditions, and the innumerable researches which require a permanent station for their successful prosecution have hardly been attempted. The mere systematic study and classification of forms in our tropical waters is glaringly incomplete, while we have almost failed to take advantage of the exceptional facilities which a tropical station offers for physiological and embryological studies, owing to the fact that the water in the tropics may be readily maintained at the same or at even a lower temperature than that of the ocean itself. In consequence of this and of the remarkable purity of the ocean water at the Tortugas and Bahamas, it is possible to rear larvæ or carry out physiological experiments with far better success than is attainable in our northern stations. If much has been accomplished in work upon the limited fauna of the southern New England or Carolina coasts, how much more might be expected from a study of the far richer fauna under the more favorable conditions attainable in the tropical Atlantic.

The cause of this neglect has been that none of our educational institutions has been able to afford to maintain a permanent laboratory in the tropics, and no cooperation has yet been, or is likely to be, effected which could bring such a laboratory into being.

The establishment of the Carnegie Institution has suddenly changed the aspect of the case, and as it appears to be the province of this institution to support important research work which none of our existing institutions has been able to afford, the prospect for the establishment of a permanent research laboratory in the tropical Atlantic appears for the first time possible.

As far as the writer is aware, no application for the establishment of such a laboratory has yet been addressed to the

Carnegie Institution. Were such an application to be made, it would appear that it should be national in character and that it should aim to secure a laboratory under conditions which will meet with the entire approbation of our leading naturalists. and which will be visited by an able and numerous clientage. The Carnegie Institution being national in scope, is the only one in the country which may hope to secure completely this combination of happy auspices, should it decide to establish such a laboratory.

In order to determine the sentiment of the country concerning the advisability of establishing such a laboratory, letters were sent to leading zoologists of the United States and Canada. Similar letters might also have been sent to the marine botanists, but it appeared probable that the general consensus of opinion concerning the proper situation and advisability of establishment of such a laboratory could be gleaned from the replies of the zoologists alone.

These letters read as follows:

An expression of opinion by leading biologists concerning the advisability or inadvisability of establishing a marine biological laboratory for research at the Tortugas, Florida, or at some other station in the American tropics, will be gratefully received by the undersigned. No definite steps leading to the establishment of such a station should be undertaken until the consensus of opinion and the desires of the leading workers in biology have been ascertained.

Do you approve or disapprove of the plan of establishing a laboratory for research in marine biology at the Tortugas?

If not, what alternative would you suggest?

If established would the station be of any practical service to you, to your colleagues, or to your students?

Criticisms as well as commendations of the plan are equally desired, and both will be published and discussed in a judicial manner in some leading journal of science.

As the replies may be numerous, it is desirable that each should be brief. Your letter may be addressed to the undersigned at the Museum of the Brooklyn Institute of Arts and Sciences, Eastern Parkway, Brooklyn.

Replies were received from the following forty-three zoologists: M. A. Bigelow, Chapman, Conklin, Dall, Davenport, Dean, Dodge, Edwards, Evermann, Gill, Hargitt, Herrick, L. O. Howard, Jennings, H. P. Johnson, D. S. Jordan, V. L. Kellogg, Kingsley, Lillie, Lucas, MacBride, McMurrich, Metcalf, Mills, Minot, Montgomery, Morgan, Neal, Nutting, Ortmann, G. H. Parker, Rathbun, Ritter, Sedgwick, Springer, R. M. Strong, Treadwell, Verrill, H. B. Ward and four others whose names we are not at liberty to reveal.

All expressed the hope that a well-supported marine laboratory for research might be established in the tropical Atlantic.

Twenty zoologists expressed the opinion that the Tortugas, Florida, would be the best situation for such a laboratory. Among these at least twelve have been upon one or more expeditions to various parts of the American tropical Atlantic.

Sixteen zoologists expressed the hope that a station might be established somewhere in the tropical Atlantic, but were non-committal concerning the best locality. Only three of these sixteen are known to have been upon any expedition to the American tropics.

Seven favored localities other than the Tortugas. Four of these preferred the Antilles,* two the Gulf coast of the United States, and one the Bermudas. All of these seven have been upon expeditions to the tropical Atlantic.

Recapitulating, we see, that of the twenty-two who have been upon expeditions to the tropical Atlantic, twelve favor the Tortugas, three are non-committal, four prefer the Antilles, and one the Bermudas. It is apparent that among those who can speak from personal experience

* Jamaica was specified by two.

the majority favor the Tortugas as a fit locality for the establishment of the laboratory.

Concerning the use which would be made of a tropical laboratory, twenty-two stated that they would expect to visit it and carry on research work under its auspices, sixteen either failed to answer the question or were non-committal, while five stated that the laboratory would be of no personal use to them.

It would appear that, in order to insure the constant use of such a laboratory, it would be necessary to assure the proper publication of all creditable researches and to defray at least a portion of the traveling expenses of students. The latter provision would probably be essential for the first few years of the existence of the station, but would become less imperative later.

We here reproduce a few of the letters which were received and which throw light upon the situation from various points of view:

"From an ornithologist's point of view the Tortugas afford exceptional opportunities for the study of bird migration and of the life history and social relationships of colonial nesting birds. Having no resident land birds, and evidently lying in a highway of migration between western Cuba or southern Yucatan and Florida, the host of migrating birds which visit the Tortugas in the spring and fall write their records on a clean page. That is, the movements of migratory birds are not confused with those of resident species or of merely local wanderers, as is apt to be the case on the mainland. This would be especially true in studying the southward migration of birds which, in the Tortugas, would probably begin late in July. I say probably, simply because we as yet know little or nothing about the early stages of the migratory movements from the United States. At this time, too, an observer in the Tortugas would be admirably situated to secure much interesting data as to whether old or young birds lead the migration of their species. Comparison of his observations with those already recorded from the Florida mainland would also show how much of the Tortugas migration was directed to or from Florida and how much of it might be termed pelagic. In short, many of the phenomena of bird migration would be observed under far less complex conditions than occur on the mainland.

"The colonies of terns which annually visit the Tortugas to nest would afford a most interesting subject for continuous study by a student who at the same time could be engaged in laboratory research along other lines. The remarkable tameness of these birds permits of that close study of the individual without which the study of the species is always more or less lacking in definiteness, and I know of no more promising subject for ornithological investigation in the field than the life-history of the noddy tern and its social relationships to birds of its own species as well as to those with which it is associated."

FRANK M. CHAPMAN.

"I am heartily in favor of the plan of establishing a research laboratory at the Tortugas, for the following reasons:

"1. The fauna of the coast of the Gulf States is less well known than that of the Red Sea, and is the least known of our coast line, although it is probably the richest. This is partly due to the fact that students of zoology are usually free only during the summer, when the Gulf coast is supposed to be too hot. Your plan will attract occasional winter workers and others in the spring and autumn.

"2. The isolation of the Tortugas is their safety. Parasitic diseases are to be feared only in a larger community.

"If established, I should be tempted to visit the laboratory; I have no doubt Chicago University would be represented by workers there nearly every year."

CHARLES B. DAVENPORT.

"I am very glad, indeed, to send you an expression of my opinion regarding the fitness of the Dry Tortugas as a point for the establishment of a zoological station. For I have collected myself in Florida waters, and I know at first hand what valuable material is to be secured there for research. As far as I can understand the problem of faunal distribution, water currents, and the like, I am decidedly of the opinion that there is no better general locality for a zoological station than the one which you are interested in. The only objection to it, as far as I can see, is the matter of ferriage to and from the mainland, but I think this is counterbalanced by the ad-

vantages derived from the offshore currents. My belief is strong that we have reached the point in our zoological studies when it is necessary to provide investigators with working facilities at a number of conspicuous faunal points along our coasts, and I think that there could be no better move in this direction than by the establishment of a station in the locality you suggest."

Bashford Dean.

"I highly approve of the plan of establishing a laboratory in this or a similar locality, as part of a general plan of a series of stations on the Atlantic coast in the centers of the successive Atlantic faunæ.

"The station would certainly be of great practical service to many American zoologists, and I would hope to make some use of it personally. It appears to me that such a station should be open throughout the year; in this way it would best supplement the uses of the more northern stations, which are principally summer stations. At present there is no opportunity in this country for marine work in the late fall, the winter and the early spring, and I am very sure that in a short time, when the advantages of the location became known, the station would have numerous visitors during these portions of the year. So far as the fauna differs from that in the vicinity of more northern stations, the location would possess advantages for special workers at all seasons."

Frank R. Lillie.

"Your letter asking my opinion regarding the establishment of a marine biological laboratory for research at the Dry Tortugas has been received.

"In reply I will say that I am enthusiastically in favor of the plan. As you know, I have some personal knowledge of the Tortugas as a field for biological work, having spent some time there with a party from this university, and I have frequently expressed the opinion that it is the best place for a laboratory that I know of on the eastern coast of the United States. It has several advantages that seem to me to be unique, and no very serious disadvantage, now that the quarantine station has been removed.

"If such a station were established I am sure that it would be of practical advantage to me and to students from this university.

"Of course a good deal depends upon the plan that is adopted. I am not informed as to whether you have formulated any definite plan. If you have, I would be glad to know of it, and would like to have this university have some share in the matter. Of course I can promise nothing officially, but it seems to me that the state universities of the west could be led to see the great service that such a station might be made to render them. The Tortugas are no farther than the New England coast, so far as western institutions are concerned, and the faunæ of the two are not comparable, so great is the advantage of the Tortugas over the North Atlantic coast.

"I would be glad to help in the furtherance of your plan in any way that I can. Please keep me advised as to progress."

C. C. Nutting.

"Your inquiry regarding the advisability of the proposition depends upon the standpoint of the individual for its reply. The *practical* question is whether sufficient funds can be secured for the proper establishment of the laboratory, and this is a problem which will color a reply to the subsequent questions, for I do not believe that a poorly equipped or otherwise unsatisfactory laboratory would be of any very great advantage to the country at large, however much it might be useful for the few workers who under such conditions might spend a short time at it.

"I have prefaced my remarks by this statement for the reason that so many projects have been entered upon in this country without means for putting them into satisfactory operation, and with the result that they have been of comparatively limited value.

"Reverting now to the specific questions proposed, and replying to them simply from the scientific standpoint, and without regard to the practical questions of access as well as support as mentioned above, I may say as follows: The location appears to me as peculiarly fortunate for the investigation of marine biology and as offering better possibilities in prospect than any of which I know in this country. I can foresee that the station would be of much practical value to the country at large. Whether, considering the distance of Nebraska from the ocean and the expense incident to the trip, it would be possible for me individually or for my students to take advantage of the opportunities offered I can hardly say in advance. I know from the way in which your article was discussed in our zoological seminar that no project has appealed more strongly to its members than precisely this one. I feel as if it were time that we had a satisfactory subtropical laboratory, and I know of no place which would be superior to the location you suggest."

Henry B. Ward.

"In general I think that the establishment of a tropical station is highly desirable, but I must confess that, so far as I am personally concerned, or so far as any of my students are concerned, it is not probable that we would be able to make any practical use of a station at the Tortugas. The one great objection to the Tortugas as the site for a station is its relative inaccessibility. One other objection has occurred to me, namely, that the fauna is exclusively marine, whereas by locating a station on some one of the larger islands—for example, Jamaica—it might be possible to have a considerable tropical land fauna as well as marine fauna. I have never visited the Tortugas and can not speak from experience as to whether the advantages there offered entirely overcome the objections I speak of. If so, the station ought to be located there irrespective of these objections. If, however, similar advantages can be found, say on the island of Jamaica, I should myself prefer to see such a station established at that point."

E. G. CONKLIN.

"The proposition to establish a marine laboratory on the Tortugas Islands certainly has much to commend it, and so far as the fauna of the Gulf Stream is concerned, probably, as you suggest, no better station in the West Indies could be chosen.

"The advantages of small islands in affording immunity from tropical diseases are no doubt considerable, yet it must be remembered that a greater land area and a more diversified coast add intensely to the interest of students who go to the tropics for zoological or botanical studies.

"I hope that the attempt to inaugurate a tropical marine laboratory will become a national one, and that before any site is definitely chosen a thorough zoological reconnaissance will be made of the larger islands, particularly of Porto Rico, on its southern shore. The future may see the establishment of a large central station with one or more subordinate ones. In any case you have advanced the idea by setting forth the strong claims of the Tortugas, and I hope that the zoologists of America will take up the question in earnest."

FRANCIS H. HERRICK.

"The plan to have a laboratory in the Caribbean region is excellent. It is something we have long needed. What you say concerning the favorable character of the Dry Tortugas would lead one to think this an exceptionally good location, but this is a point that requires very careful and thorough consideration. It would be well to look to the fate of laboratories established on small islands and in other out-of-the-way places. We have the Anderson Laboratory on Penekese as a horrible example. A marine laboratory should be in touch with the rest of the world. Perhaps the Tortugas fulfill this condition; but the land fauna is to be considered. In a region like the Caribbean especially it is no less important than that of the sea. Insular forms are in constant danger of extinction; hence it is incumbent upon us of this generation to give them as much study as we can. It is doubtful whether the Tortugas or even the Bahamas offer so good a site as the Greater or even the Lesser Antilles, from this point of view."

HERBERT P. JOHNSON.

"Never having been there, I can not speak of the place as a desirable residence, nor of the facility for going and coming, which are of course very important considerations for students and scientific men, but my impression has been that it was rather expensive going there from the north, and not a very agreeable climate except perhaps in the coldest months. As for the marine fauna there, I can speak in the highest terms of its richness and variety, for I have studied the fauna of that region for many years. There can be no question as to the excellence of the place for obtaining abundant material of all kinds of marine life. Perhaps the very richness of the fauna would be embarrassing to many. My own preference would be Bermuda, probably because I have become familiar with that locality. The fauna there is less rich, of course, but the climate, especially in the spring and early summer months, is more favorable for work and study, being more temperate, and I suppose it is easier and considerably cheaper to go there. Perhaps the social conditions, also, are superior in Bermuda. There would be no lack of materials in either place, and a biological station in either place would be of great value to the progress of science."

A. E. VERRILL.

"I am in hearty sympathy with the attempt to establish a station in the Tortugas, although I think Jamaica would be a better place for a tropical station. One of the most important considerations is accessibility, and in this respect Jamaica has the advantage. Whatever place is selected, some way should be planned to reduce the traveling expenses to a minimum. This would be, I think, an important element in the success of a distant station."

T. H. MORGAN.

It appears to the writer that as the number of persons who will work at a research laboratory is relatively small, richness of fauna and healthfulness of location are probably of more importance than accessibility.

Ideal conditions for a laboratory can not be found in the tropical Atlantic.

The mainland Florida coast is infested with mosquitoes in summer, and its pelagic life is relatively poor. The climatic conditions and healthfulness of the Antilles are not of the best, while their marine fauna is probably inferior to that of the Bahamas or Tortugas. They possess, however, a restricted but interesting land fauna and flora.

The Bahamas lie upon the windward side of the Gulf Stream, and on this account their pelagic life is probably poorer than that of the Tortugas.

The Tortugas are relatively inaccessible, but here we find very pure ocean water, a relatively cool climate, a long period of remarkably calm weather during the late spring and summer, healthfulness due to isolation, and few mosquitoes. The last-named advantage will be appreciated by all who have attempted to live upon the Florida coast or the West Indies in summer.

Were a research laboratory to be established under the auspices of the Carnegie Institution, it might seem advantageous to found it in cooperation with such of our leading universities and colleges as are granting the doctorate for original research. As a tentative proposition, each college might contribute at least $150 annually for each student which it might send to the laboratory, thereby gaining the privilege of nominating students, who, subject to the approval of the Carnegie Institution, should be given free use of all facilities of the laboratory for the purpose of carrying out some definite research work. The traveling expenses of this student should be paid by the laboratory and his research should be published in a suitable manner with illustrations. The proper maintenance of such a laboratory would require an assured annual income of at least $10,000. It would be better to abandon the project than to attempt to carry it out with inadequate equipment and income.

In conclusion, it should be stated that the sole aim of the present writer is to focus the interest of the country upon this project; he desires no official connection with the laboratory, but speaks merely as one of at least forty-three zoologists who are interested in the project. There would appear to be no better medium for a thorough consideration of the subject than the columns of SCIENCE, and it is hoped that sufficient interest will be awakened to evoke an active discussion of the project from all points of view.

The establishment of the Carnegie Institution has, in increasing the possibility for the development of research, placed a corresponding responsibility upon each and every man of science. No laboratory should be founded unless our biologists ardently desire its establishment, and stand ready to avail themselves of its advantages to the fullest extent.

A. G. MAYER.

MUSEUM OF THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES.

SCIENTIFIC BOOKS.

I. *Experiments on the Effect of Freezing and other low Temperatures upon the Viability of the Bacillus of Typhoid Fever,* with considerations regarding ice as a vehicle of infectious disease.

II. *Statistical Studies on the Seasonal Prevalence of Typhoid Fever in Various Countries and its Relation to Seasonal Tempera-*

ture. By WILLIAM T. SEDGWICK and CHARLES-EDWARD A. WINSLOW. *Memoirs of the American Academy of Arts and Sciences,* August, 1902, Vol. XII., No. V.

In these two papers by Professor Sedgwick and Mr. Winslow—one dealing with their personal experiments on the viability of typhoid bacilli in ice, and the other a statistical study of the determining factors of the seasonal prevalence of typhoid in various countries—we have presented to us an array of interesting data, and especially is this true of the second paper, in which the authors in a painstaking manner have brought together, correlated and made deductions from the statistics of typhoid fever prevalence in many and diverse localities.

Constantly recurring outbreaks of typhoid fever, even where rational precautions seem to have been taken to insure the safety of the public, and the never-failing seasonal rise and fall due to conditions often not fully understood, lend a peculiar interest to all trustworthy investigations bearing on these problems. Bacteriology has already aided in the solution of many obscure problems of disease and its dissemination. The etiology of various diseases has been established beyond all reasonable doubt and much information has been gained in regard to the life histories of many pathogenic bacteria. Yet, in the majority of instances, few, or at best unsatisfactory data have been brought to light in regard to the conditions of the life of these organisms in nature, their habitat outside of the bodies of infected animals and man, and the extent of their distribution. Little is known positively of the conditions of their increase, survival or destruction in nature in the various soils, water, ice, etc., and the effects of variations in temperature, especially those due to seasonal changes on their life and growth. The solution of these problems is of prime importance, and its accomplishment must eventually lead to the establishment of more rational, sure and, it may be assumed, often less irksome precautions for the protection of the individual or community. The outcome of such investigations tends in general toward two principal ends: either to indicate danger where none was supposed to lurk, or to dissipate the fear of a danger which does not exist.

It may well be urged that few, if any, epidemics or even individual cases of typhoid fever occur that could not have been prevented by the intelligent application of knowledge at our disposal, yet the fatal neglect of well-known precautions by those in power, and the criminal negligence or ignorance of those upon whom we are forced to depend for much of our water, ice, milk and food supply, leave us little confidence in the bacterial purity of these in their natural state. In this connection the experiments of the authors on the viability of typhoid bacilli in ice have a special interest even for the general reader, since the facts presented and the conclusions reached are, on the whole, of a reassuring nature. Space will not permit of a review of these experiments in detail. They follow very closely in scope and character those carried out and reported in 1887 by Dr. Prudden. Prudden's work, although done many years ago and under certain conditions which the present investigators have thought fit to eliminate, has been largely confirmed and slightly extended. The chief departure in technique consisted in the substitution of freshly isolated typhoid bacilli for typhoid bacilli that had been for some time cultivated on artificial media, and the gradual lowering of the temperature during the process of cooling and freezing, so as to avoid a too abrupt temperature change, since Bordoni-Uffreduzzi claimed that on account of the rapid changes of temperature in Prudden's experiment and his use of attenuated cultures his results could only have a relative worth, and the results accomplished under natural conditions could not be directly deduced from them.

As a result of the authors' experiments on freezing typhoid bacilli in water and keeping them at 0° C. or below, the conclusion is drawn that less than one per cent. of the typhoid germs present in water can survive fourteen days of freezing, and that during the first half hour of freezing a heavy reduction takes place amounting to perhaps fifty per cent.; after this 'the reduction proceeds pretty regularly as a function of time.'

In this experiment the results of the analysis of control tubes left at the ordinary temperature have not been recorded. This appears to the reviewer a serious defect, as the authors seem to have entirely overlooked the fact that the transfer of organisms from one fluid to another, especially if these fluids be not isotonic, generally results in the destruction of many of the organisms, and that this fact renders it impossible for them to determine the exact part played by the lowered temperature. This defect is somewhat remedied by a comparison with a following independent series of experiments on the effect of temperatures slightly above the freezing point. Their conclusion from this series is largely what our knowledge would lead us to expect, namely, that typhoid bacilli behave in water much as they do in ice: "A large proportion of them are killed by a few minutes' exposure to the unfavorable conditions (cold?); during the next few hours the reduction proceeds *pari passu* with the duration of the experiment; while a few germs persist for some time." The results differ from those obtained by actual freezing in two respects. Freezing for short periods produced varying and uncertain results; ice over twenty-four hours old showed a constant reduction of over ninety per cent. In water the period of uncertainty was much extended; some of the water tubes containing half of their germ contents after a week. Complete sterilization, however, ensued more often than in frozen tubes. "The reduction in water at 10° C. does not seem to be greater than at 20° C." Here, as was surmised above, the temperature probably plays a minor part, and the decrease is largely, no doubt, due to other unfavorable conditions. We do not consider, therefore, that the authors have established in a more definite manner than their predecessors the exact part played in the destruction of bacteria by freezing and low temperatures. Their experiments may indicate in a fair degree the sequences of events when typhoid or other bacilli are suddenly transferred to water from some more favorable environment, but do not establish the behavior of those organisms which may have become accustomed to such new surroundings.

Our attention has also been attracted by a statement of the authors, that bacteria settling to the bottom 'may soon perish for want of air.' This statement must be born of pure hypothesis, as cultures of typhoid bacilli will in fact live for years anaerobically.

The result of experiments on the viability of typhoid bacilli in sterilized earth at various temperatures was the following: Typhoid bacilli in dry earth behave just as in water and ice. They die out rapidly at first, and their numbers are progressively reduced as the treatment is prolonged. A fraction of one per cent. persists for some time. Cold alone does not materially effect the reduction of typhoid germs in dry earth. In moist earth the destruction of the bacteria is much less rapid; at times when food supply is plentiful they appear to hold their own.

In another set of experiments it was found that sedimentation did not produce marked or constant effects on colon and typhoid bacilli in water during as short a period as twenty-four hours. Ice, however, formed on the surface of a quiet body of water contained only about ten per cent. of the bacteria present in the water. This difference, they conclude in agreement with various observers, is due to the physical exclusion by the process of crystallization, and not to any germicidal action, as the temperature of the ice can only differ from that of the adjacent water in a very slight degree. There are two forces at work: low temperature killing off the germs in ice and water nearly equally, and the crystallizing process extruding germs from the ice into the water.

The general conclusions and applications of the results of the experiments as given by the authors may be summed up somewhat as follows: The main factor determining the reduction of germs in water is *time*—the time during which the various purifying forces are left to act. Epidemiology shows clearly that disease follows most often a direct, quick transfer of infectious material from patient to victim; and if storage of water for some months could be insured, many sanitarians would consider such storage a sufficient purification. In ice this condition is realized—

a forced storage of at least weeks and at best of many months. In natural ice, besides the action of cold, there is another purifying influence, the exclusion of ninety per cent. of the germs by the act of freezing. Under natural conditions the pathogenic germs present in the most highly polluted stream are comparatively few. Of these few, one tenth of one per cent. may be present in ice derived therefrom. Even these scattered individuals are weakened by their sojourn under unfavorable conditions, so that it is doubtful if they could produce many, if any, cases of typhoid fever. With artificial ice the case is different, for such ice is made from water frozen solid and, as a rule, quickly consumed. Such ice, therefore, if made from impure water may contain the germs of infectious disease, and, being used quickly after its manufacture, may be a menace to the public health. With natural ice also there must always remain an element of doubt. Polluted ice might be cut at once, and served within a week or two, and sufficient disease germs might persist to cause infection. Yet the authors think such an instance must be very exceptional; and the general result of human experience, the absence of epidemics of typhoid fever traced conclusively to ice; the fact that cities like New York, and Lowell and Lawrence, Massachusetts, have used ice of polluted streams and have yet maintained low death rates from typhoid fever, all tend to support the conclusion at which they have arrived, namely, that natural ice can rarely be a vehicle of the infectious agent of typhoid fever.

Such results and conclusions as these, coming from this high authority, confirming in essential details the work of other investigators, as well as extending our knowledge of this important subject, are somewhat reassuring in regard to the use of ice.

This is especially true from the standpoint of the general sanitarian, who, accepting these data, may look upon stored ice as a neglectable sanitary quantity, and to the statistician in his estimates of usual sources of disease; but in the opinion of the reviewer, the individual facing the element of doubt in the purity of ice, and especially as ice is so universally handled just prior to using, should not be led by the purity of the ice in general to abate any reasonable precautions for his own protection. It has been too much our habit, as many fatal epidemics bear witness, to take chances in matters sanitary, and to bend to expediency and personal or public convenience rather than to strive for the ideal.

Such papers are apt to convey the impression to the lay and even, it is to be feared, to the official mind, that sanitary precautions may be neglected in the use of ice. Let us urge, however, that it is small comfort to the individual suffering from typhoid fever contracted from polluted ice to be told that ninety-nine per cent. of his friends use ice with impunity.

In the studies of statistics on the seasonal prevalence of typhoid fever in various countries and its relation to seasonal temperature, the authors review fully the literature on the seasonal prevalence of typhoid fever, setting forth at some length the various data as to the time of maximal and minimal occurrence, and the hypotheses that have been advanced in explanation of those variations. Chief among these, historically at least, as is so well known, is the view, supported by Pettenkoffer and his school, that there is a relation between the variations in level of the ground water and variations in the prevalence of typhoid—typhoid cases being abundant when the ground water is lowest. The only plausible explanation of the connection, however, between ground water and typhoid fever on the basis of the germ theory is, in the opinion of the writers, that furnished by Liebermeister, who in 1860 suggested that the phenomena might simply be due to the concentration of soil impurities in the wells at the time of low water, and their transmission in unusually large doses to those who drank therefrom. Dr. Baker in this country advocates this idea with modification, and a recognition of the fact that a well in use drains a wider area when the ground water is low and is thus liable to pollution from more distant sources.

Whatever the explanation, it seems to be true that at Munich in the period studied by

Pettenkoffer and his followers, a real relation did exist between ground water level and typhoid. In no other case, so far as the authors are aware, has the possibility of the influence of temperature been excluded. This varies inversely with the ground water and directly as typhoid fever, and the seasonal curve in many places may be more plausibly explained by this than by variations in ground water.

Murchison was the first forcibly to call attention to the importance of the temperature factor. Plausible as the explanation appears, it has not gained wide acceptance, and, as stated by the authors, has been practically ignored in Germany. In summing up this subject, they say: "Although most observers have noted a characteristic seasonal distribution of typhoid fever, others, including some of those who have written most recently, have denied the existence of such variations. Of those who realized that the variations did exist, a few sought an explanation in the factor of temperature. Their views did not, however, gain acceptance, as the evidence furnished was insufficient; and the common view among medical men and sanitarians has been that the fall maximum of typhoid fever was an unexplained phenomenon."

Sedgwick and Winslow have attempted, by careful collection and comparison of statistics, to see whether the relation shown by Murchison, Liebermeister and Davidson for a few places could be demonstrated for a wider field. They have, therefore, brought together statistics of the monthly variation in temperature and the prevalence of typhoid fever for thirty communities. These include the states of New York and Massachusetts, the District of Columbia, Baltimore, Boston, Charleston, Chicago, Cincinnati, Denver, Mobile, Newark, New Orleans, New York, Oakland, Philadelphia, St. Paul and San Francisco in the United States; the city of Montreal in Canada; the cities of Berlin, Dresden, Leipsic, London, Munich, Paris and Vienna in Europe; the Empire of Japan, and the British Army in India in Asia; and the cities of Buenos Ayres and Santiago de Chile in South America. Four continents and both hemispheres are thus represented, and a wide range of climate.

Monthly values for temperature and typhoid prevalence have also been plotted on appended plates in order to show graphically the relation of the two curves.

An examination of the plotted curves shows a remarkable parallelism between monthly variations in temperature and typhoid prevalence. Of the thirty communities considered, eighteen show the parallelism to be almost perfect. Three other typhoid curves, those for India, for Charleston and for New Orleans, rise with the temperature in spring, and fall with it in autumn, but show a temporary decrease in the disease during the time of greatest heat. In these twenty-one cases the connection between the two factors seems too close not to indicate a vital relation. In northern cities the course of typhoid is acute; in cities with more and more equable temperatures the curve is progressively flattened.

In the northern localities the maximum occurs in September and October; in southern cities with a milder winter it comes in August or July. In the two cities of the southern hemisphere (Buenos Ayres and Santiago) the curves of both typhoid fever and temperature are exactly reversed. In the case of the tropical and subtropical regions—India, Charleston, New Orleans—it appears that the rise with the temperature, after beginning in the usual fashion, is checked by some other factor, perhaps strong sunlight or extreme dryness.

In the case of the nine cities which show more or less irregular curves, the authors call attention to a factor much neglected by previous students of seasonal variations; *i. e.*, the necessity of discriminating between sharp epidemic outbreaks and the slow succession of isolated cases which characterize that condition usually known as 'endemic.' They lay stress upon a distinction, vital to epidemiologists, which must be drawn between infection which reaches a number of persons at once through a single medium, as water or milk, and the slower, more complex process by which a disease passes from person to person; the path of the contagious material being

different in each individual instance. The term 'prosodemic' has been used to describe this form of infection. Such prosodemic disease, they rightly consider, should be mainly considered in the analysis of data bearing upon seasonal prevalence. An epidemic must always be looked upon as a perturbing element. Curves based upon a small number of cases will always be liable to show irregularities due to single epidemics, and this is the explanation in four of the nine cities of their irregular seasonal curves. In the case of the other cities, the curves of which are based on ample statistics—Chicago, Cincinnati, Newark, Paris and Philadelphia—the curves show secondary maxima—one in December or January, the other between March and May. These five cities draw their supply from surface sources liable to gross pollution. Heavy autumn rains and spring floods carry into these surface water supplies a larger amount of pollution than reaches them at any other time.

The authors generalize: Winter and spring epidemics are characteristic of those cities whose water supply is most subject to pollution; they are absent from communities which use filtered water or water obtained from adequately protected watersheds. They conclude that wherever a sufficient number of cases have been considered a direct relation between typhoid fever and temperature appears to be general and invariable.

The probable mechanism of the seasonal changes, according to their conception, may be given in their own words: "The bacteriology and the etiology of typhoid fever both indicate that its causal agents can not be abundant in the environment during the colder season of the year. The germs of the disease are carried over the winter in the bodies of a few patients and perhaps in vaults or other deposits of organic matter, where they are protected from the severity of the season. The number of persons who receive infection from the discharge of these winter cases will depend, other things being equal, upon the length of time for which the bacteria cast in these discharges into the environment remain alive and virulent. The length of the period during which the microbes live depends largely upon the general temperature; as the season grows milder, more and more of each crop of germs sent at random into the outer world will survive long enough to gain entry to a human being and bear fruit. The process will be cumulative. Each case will cause more secondary cases, and each of the latter will have a still more extensive opportunity for widespread damage. In our opinion the most reasonable explanation of the seasonal variations of typhoid fever is a direct effect of temperature upon the persistence in nature of germs which proceed from previous victims of disease."

This paper on the seasonal prevalence of typhoid fever merits a careful study in the original, and, in the main, one familiar with this subject must be impressed with the justness of the conclusions based upon the data there brought together.

PHILIP HANSON HISS.

SCIENTIFIC JOURNALS AND ARTICLES.

THE April number of the *Transactions* of the American Mathematical Society contains the following papers: 'The approximate determination of the form of Maclaurin's spheroid,' by G. H. Darwin; 'On twisted cubic curves that have a directrix,' by H. S. White; 'Ueber Curvenintegrale im m-dimensionalen Raum,' by L. Heffter; 'The generalized Beltrami problem concerning geodesic representation,' by E. Kasner; 'On the holomorph of a cyclic group,' by G. A. Miller; 'Quadric surfaces in hyperbolic space,' by J. L. Coolidge; 'Ueber die Reducibilität der reellen Gruppen linearer homogener Substitutionen,' by A. Loewy; 'On the possibility of differentiating term by term the development for an arbitrary function of one real variable in terms of Bessel functions,' by W. B. Ford; 'On a certain congruence associated with a given ruled surface,' by E. J. Wilczynski; 'On the class number of the cyclotomic number field $k(e^{2\pi i/p^n})$,' by J. Westlund.

THE May number of the *Bulletin* of the American Mathematical Society contains: Report of the February meeting of the

American Mathematical Society, by F. N. Cole; 'On the foundations of mathematics' (presidential address), by E. H. Moore; 'Concerning the axiom of infinity and mathematical induction,' by C. J. Keyser; 'A German calculus for engineers' (review of Fricke's 'Calculus'), by E. R. Hedrick; Notes; and New Publications.

The current number of the *American Journal of Mathematics* contains the following articles:

Edward Kasner: 'The Double-Six Configuration Connected with the Cubic Surface, and a Related Group of Cremona Transformations.'

Saul Epsteen: 'Untersuchungen über lineare Differentialgleichungen 4. Ordnung und die zugehörigen Gruppen.'

A. N. Whitehead: 'The Logic of Relations, Logical Substitution Groups and Cardinal Numbers.'

John Wesley Young: 'On a Certain Group of Isomorphisms.'

F. E. Ross: 'On Differential Equations Belonging to a Ternary Linearoid Group.'

The April Number of the *Biological Bulletin*, Volume IV., No. 5, contains the following articles:

Edmund B. Wilson: 'Notes on Merogony and Regeneration in *Renilla*.'

Carl H. Eigenmann and Clarence Kennedy: 'Variation Notes.'

Walter S. Sutton: 'The Chromosomes in Heredity.'

Henry Leslie Osborn: 'On *Phyllodistomum americanum* (n. sp.); a New Bladder Distome from *Amblystoma punctatum*.'

Thos H. Montgomery: 'The Heterotypic Maturation Mitosis in Amphibia and it General Significance.'

Bashford Dean: 'An Outline of the Development of a Chimæroid.'

SOCIETIES AND ACADEMIES.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

It is a pleasure to record that the Academy of Science of St. Louis, which has thus far in its existence met as a tenant or guest, is now in possession of a home of its own in which it will probably be installed before the end of the current year.

Some months since, Mrs. Eliza McMillan and her son, Mr. William Northrop McMillan, offered to purchase for the academy a piece of property on Olive Street between Spring and Vandeventer avenues, in what is now coming to be the central district of St. Louis, as a memorial to the late William McMillan, who, at the time of his death, was a member of the academy. The transfer has now been effected and was announced by the council at the regular academy meeting of April 6, on which occasion the following resolutions were unanimously adopted:

"Resolved, That the members of the Academy of Science of St. Louis most gratefully accept from Mrs. Eliza McMillan and Mr. William N. McMillan, the gift of a permanent home for the academy. We feel that this generous donation will infuse new life into the institution and will insure its future usefulness. We pledge ourselves to use every effort to make it worthy of the confidence thus shown by the donors and to maintain the object of its founders, as expressed in the Act of Incorporation—'the advancement of science and the establishment in St. Louis of a museum and library for the illustration and study of its various branches.'

"Resolved by the members of the Academy of Science of St. Louis, that the property conveyed on the 18th day of March, 1903, by Edgar R. Hoadley and Luvinia L. Hoadley to the Academy of Science of St. Louis, which property is the gift of Mrs. Eliza McMillan and William N. McMillan, shall not be mortgaged or encumbered so long as it remains the property of the Academy of Science.

"Resolved, further, that the property shall not be sold except by a two thirds vote of the members of the Academy of Science of St. Louis by letter-ballot in the manner prescribed by the council, and that when sold, the proceeds of the sale, or as much thereof as may be necessary, shall be used to provide a suitable location and building for the uses of the Academy of Science."

In introducing the foregoing resolutions, Professor Nipher, long a member of the academy and for a considerable period its president, said:

"I can not allow this occasion to pass without calling attention to the great significance of the announcement which has been made this evening.

"Ever since the academy was organized, in

March, 1856, its work has been done under the most discouraging circumstances. It has never had a home. Its meetings have been held in the meeting-room of the Board of Education, at a medical college, at Washington University, and in the rooms of the Missouri Historical Society. It has never had its own home, where it might make its valuable library and its collections of real service to the citizens of our city. During all these years of its existence the academy has been collecting a library of scientific publications, in exchange with similar societies in all parts of the world. Our published *Transactions* have gone to every civilized land. We have certainly had the outward semblance of great scientific activity. There is no local academy of science in this country which can present a more creditable record of published work. Even during the Civil War, when almost every educational interest suffered, a few working investigators, aided by others who gave such support as they could give, continued to produce before this body their contributions to knowledge, and to publish them to the world in the *Transactions* of the academy.

"During all of this time these pioneers have been hoping to see this day. Year after year the president's annual report has called attention to the vital necessity of a fixed abiding-place which we could own and control. Without this we could never hope to establish a public museum of science, or to avail ourselves of our precious library.

"And now the first great advance has been made. This gift to the cause we have been striving to uphold could not have been more opportune. These enlightened patrons of higher learning have seen their opportunity, and they have volunteered their aid. The manner in which they have bestowed their bounty makes it doubly valuable and effective. They have made it impossible for us to honor them by any act within our power. They have become one with us in the cause which we have all labored to advance. May we not hope that they will permit us to enroll their names in our membership as patrons of the academy?

"And this gift brings with it new obligations for us. We should now seek to establish an endowment fund, which will enable us to make our valuable collections of books and specimens fully available to the public. During the World's Fair we shall be under examination. Learned men from this and other lands will come among us. The great public will be here. The location of our new home is such that we can not fail to attract the attention of vast numbers of our visitors. We should not only have a museum and library which will be an honor to our city, but it should be open to all. We wish to show that we have here, among the permanent institutions of our city, an academy of science which is dedicated to the advancement of human learning, and to the diffusion of knowledge among men. In this way we shall fittingly carry out the work which Mrs. William McMillan and her son, Mr. William Northrop McMillan, have so nobly begun."

On nomination of the council, Mrs. McMillan and Mr. W. N. McMillan were elected patrons of the academy.

WM. TRELEASE,
Recording Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 369th meeting was held Saturday, March 21.

T. S. Palmer told of 'The Preservation of Pelican Island as a Breeding Ground for Birds.' He said that this islet situated in Indian River, Florida, was the only place on the east coast where the brown pelican bred, and that the Audubon Society had for some time been endeavoring to secure it. It had been found that the necessary legal proceedings would require some two years' time and that the spot might, after all, be secured by another party; at the request of the Secretary of Agriculture it had been made a government reservation, one of the very few cases on record where such a step had been taken to preserve the birds.

Walter H. Evans drew attention to some deficiencies in 'The International Catalogue of Scientific Literature,' stating that in examining the volume containing the bibliography of bacteriology he had found that only a very small portion of such papers published in the United States had been recorded. He cited a number of journals whose articles had been entirely or partially omitted, and said that, on the other hand, papers were included in the catalogue that could only by courtesy be considered as bacteriological in their nature.

Vernon Bailey spoke of 'The Desert Life of Western Texas,' illustrating his remarks with views showing the characteristic features

of the flora and fauna of the region; and Paul Bartsch presented some 'Notes of the Herons of the District of Columbia.' He described at some length a colony of night herons, showing various views of the nests with eggs and young in various stages, and also exhibited some pictures of young blue herons and of the great white egret, expressing his regret that these birds had subsequently been nearly all killed by hunters.

F. A. LUCAS.

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 140th meeting of the society, held in the assembly hall of the Cosmos Club, Wednesday evening, March 11, 1903, the following program was presented:

Mr. A. J. Collier, 'Coal-bearing Series of the Yukon.'

About 9,000 tons of coal have been mined along the Yukon since 1897. Above the Tanana the coal occurs in small Eocene basins surrounded by older rocks. Below the Tanana a coal-bearing formation, called the Nulato sandstone, is exposed almost continuously for 400 miles. From the lowest beds of this series cycads of Jurassic and Lower Cretaceous aspect were obtained in the same matrix with dicotyledons of Upper Cretaceous aspect. In other places Upper Cretaceous plants and invertebrates and Eocene plants were obtained, but the horizons could not be differentiated stratigraphically or lithologically, and continuous sedimentation from the Middle Cretaceous to the Upper Eocene is suggested. The Nation River coal bed on the upper Yukon may be either Permian or Eocene overthrust by Permian limestones.

Mr. Frank C. Calkins, 'Soils of the Wheat Lands of Washington.'

The soil covering the higher portions of the Columbia plains has generally been considered to be residuary, and derived from the underlying Miocene basalt. Recent observations, however, have led the author to believe that this soil is an eolian deposit. The argument for the eolian hypothesis is based on the physical and chemical properties of the soil and the complete lack of transition between it and the underlying rock. The wind-blown material is supposed to come from the soft volcanic sediments that overlie the basalt in the southern portion of the Columbia plains.

Dr. H. S. Washington, 'The Calculation of Center-points in the Quantitative Classification of Igneous Rocks.'

After briefly explaining the main features of the new classification (see SCIENCE, February 27, 1903, pp. 341 et seq.), the speaker showed that, as the classification is strictly quantitative, the theoretical chemical and normative composition of the center-point of any given classificatory division could be calculated mathematically. This is accomplished by forming equations expressing the definition of the center-point of each successive classificatory division, from the solution of which the norm is obtained. From this the chemical composition follows. The method will be explained at length in a publication which is soon to appear.

The result of a calculation of the average igneous rock, based on nearly 2,000 reliable analyses, taken from a collection which has been made by the speaker, was also communicated. It was shown that this latest estimate approximates very closely to those of Clarke and Harker.

Professor Edward Mathews, 'The Practical Working of the Quantitative Classification.'

The author presented the salient features of the new classification as indicated by the averaging of some 500 analyses according to subrangs, rangs, orders and classes. The figures seem to indicate that the new rules are applicable with little or no subjectivity, but that little can be told with certainty regarding the classificatory position from an inspection of the chemical analysis.

The author commended the simplicity of the basal conceptions and the resulting simplicity of definitions; the suggestion of new lines of investigation developed by the classification; and the mnemonic features of the nomenclatures. He, however, criticized the choice of order names and roots, the subordination of texture, the fact that the literature would be deprived of its usefulness and the extreme emphasis likely to be placed on chemical analyses of single specimens.

The conclusion drawn by the author was on the whole favorable to the new scheme and the thought was expressed that the new classification more or less modified would bear the same relation to the present nomenclature as the scientific system in botany does to the popular plant names.

W. C. MENDENHALL,
Secretary.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 563d regular meeting was held February 14, 1903.

Rev. J. G. Hagen, S.J., of Georgetown University, spoke of 'A Peculiar Type of Temporary Stars,' the variation of which is so short in duration that it can not be confirmed by an independent second observer. The speaker enumerated and explained five instances of this character, and showed that the authorities in each case were of such weight that the existence of this type can no longer be doubted. The five instances contained two that had been known for many years, but had been accepted with great reserve. Another was published a few months ago; one was taken from unpublished manuscripts of the late E. Heis, and the last was an observation of Christoph Scheiner, S.J., in 1612, which has never been fully studied or understood. The latter especially deserved to be entered in the catalogues of variables stars as well as any other temporary star.

The next paper, by Mr. C. W. Waidner, of the Bureau of Standards, was 'A Discussion of the Practical Methods of Measuring Temperature and the Accuracy attainable by these Methods.' The paper contained a brief outline of the present state of mercurial thermometry in the range $-35°$ C. to $+550°$ C., and of the development of suitable kinds of glass for thermometric purposes; some applications of platinum thermometers, thermoelectric and specific heat pyrometers, to the measurement of temperatures, the accuracy and limitations of each of these methods; the estimation of temperatures beyond the range of these methods, *e. g.*, that of the electric arc, the Nernst filaments, etc., by extrapolation of Stefans's and Wiens's radiation laws.

CHARLES K. WEAD,
Secretary.

AMERICAN CHEMICAL SOCIETY. NORTHEASTERN SECTION.

THE forty-third regular meeting of the section was held at the 'Tech. Union,' Massachusetts Institute of Technology, Boston, Tuesday, March 31, 8 P.M., President A. H. Gill in the chair. About 45 members were present.

Professor Charles F. Mabery, of the Case School of Applied Science, Cleveland, Ohio, presented a paper, entitled 'A Résumé of the Composition of Petroleum,' in which, after a historical introduction of the subject, the lecturer stated that the subject had occupied his attention during the last twenty years, during the last ten of which, with the aid of grants by the American Academy of Arts and Sciences from the C. M. Warren Fund, and the facilities of the chemical laboratories of the Case School, he had been able to employ a corps of assistants that has made possible the vast amount of labor necessary in distilling, analyzing and otherwise identifying the constituents, distilling below 350 degrees to 450 degrees in petroleum from the field in Pennsylvania, Ohio, Indiana, Texas, California, Japan and South America. As a result of this work, it appears that the portions of petroleum distilling below the limits mentioned are composed of the series

$$C_nH_{2n+2},\ C_nH_{2n},\ C_nH_{2n-2},\ C_nH_{2n-4}.$$

The sandstone oils, such as the Pennsylvania deposits, contain the continuous series

$$C_nH_{2n+2},\quad \text{up to}\quad C_{28}H_{58},$$

and doubtless higher, but this is the limit of possible molecular weight determinations at present. Ohio Trenton limestone oil contains members of this series up to and including $C_{11}H_{24}$, and also the so-called solid paraffine hydrocarbons; but the series

$$C_nH_{2n},\ C_nH_{2n-2},\ C_nH_{2n-4}$$

form the greater portion of the Ohio oil. Associated with the solid paraffine hydrocarbons are liquid bodies of the series C_nH_{2n} and C_nH_{2n-2} in smaller proportions.

Petroleum from the corniferous limestone in Canada resembles Ohio petroleum in containing the series C_nH_{2n+2}, up to $C_{11}H_{22}$, but this oil contains larger portions of the heavier series

$$C_nH_{2n},\ C_nH_{2n-2},\ C_nH_{2n-4},$$

which explains its higher specific gravity. In Texas and California petroleum the series $C_n H_{2n+2}$ does not appear, and the main body of the oil is composed of the series poorer in hydrogen.

As a result of the above investigations, petroleum can be defined as a mixture of a few series of hydrocarbons, and products from different fields differ only in the proportions of the series contained in them. A great field for chemical research yet remains in ascertaining the structure of the series described above, and of the so-called asphaltic hydrocarbons, which can not be distilled without decomposition. The composition of the oil from different fields should have an important bearing on the question of the formation of petroleum, and there is a field for the chemical geologist to study, more intimately than has yet been done, the occurrence of petroleum in connection with its composition.

Arthur M. Comey,
Secretary.

IOWA ACADEMY OF SCIENCES.

The seventeenth annual meeting of the Iowa Academy of Sciences was held in Des Moines, December 30 and 31, 1902.

The following papers were presented at the sessions:

'Living Plants as Geological Factors,' by B. Shimek. This was a discussion of the influence of living plants in checking erosion and thus overcoming in part the destructive action of running water. Their constructive effect was also considered, and examples were given of their influence in the formation of new deposits by serving as an anchorage for materials brought from a distance. Plants are believed to have been important factors in the formation of the loess. There is much evidence that the loess was deposited by the wind upon plant covered land surfaces.

'The Solar Surface During the Past Twelve Years,' by David E. Hadden. This paper was a review of a series of sunspot observations made by the writer from 1890 to 1902. Daily observations were taken, usually about noon in the autumn and winter and between seven and eight o'clock in the morning during the warmer season. During the period under review about 1,750 groups were observed on the visible disk, the greatest number, 285, being registered in 1893, and the least number, 18, in 1901.

'The Origin of the Lignites of North Dakota,' by F. A. Wilder. All the workable lignite beds of North Dakota are regarded as being of Laramie age. The beds of this age consist mainly of clays which are not fissile or shale-like, and the lignite is interstratified with these clays. The lignite is believed to have been formed in fresh-water lakes which originated during the Rocky Mountain uplift and were fed by streams coming from the west. These rapidly flowing streams would carry much timber and deposit it in the lakes, thus giving rise to the vegetable accumulations which produced the lignite.

Other papers presented were the following:

H. E. Summers: Presidential address, 'Some Problems of Heredity and Evolution.'

L. H. Pammel: 'Some Ecological Notes on the Vegetation of the Uintah Mountains.'

Frank L. Almy: 'Some Observations upon the Action of Coherers when Subjected to Direct Electromotive Force.'

Howard E. Simpson: 'The Accretion of Flood Plains by Means of Sand Bars.'

B. H. Bailey: 'The Duck Hawk (*Falco peregrinus anatum*) in Iowa.'

H. W. Norris: 'The Membrane Bones in the Skull of a Young Amphiuma.'

A. N. Cook: 'The Preparation of Phenylether.'

A. N. Cook and W. J. Morgan: 'The Sioux City Water Supply.'

C. R. Keyes: 'Significance of the Occurrence of Minute Quantities of Metallic Minerals in Rocks.'

C. R. Keyes: 'Genesis of Certain Cherts.'

J. B. Weems and Alice W. Hess: 'The Chemical Composition of Nuts as Food.'

J. B. Weems and E. C. Myers: 'The Preparation of Ammonia-free Water for Water Analysis.'

T. E. SAVAGE: 'The Toledo Lobe of Iowan Drift.'

T. J. and M. F. L. FITZPATRICK: 'The Scrophulariaceæ of Iowa.'

L. H. FORD: 'Smallpox in the Public Schools.'

'Notes from the Chemical Laboratory of Cornell College.'

W. E. SANDERS: 'A Study in Psychopathic Heredity.'

The membership of the academy was increased by the addition of the following fellows: T. C. Frye, D. W. Morehouse, H. C. Price and B. C. Lanphear; the new associate members are Lucy M. Cavanagh, Harriet Clearman, Fred Seaver, A. M. Allen and R. E. Buchanan.

The newly elected officers are:

President—B. Fink.
First Vice-President—S. W. Beyer.
Second Vice-President—Maurice Ricker.
Secretary—A. G. Leonard.
Treasurer—H. W. Norris.

A. G. LEONARD,
Secretary.

THE KELVIN PHYSICAL CLUB OF THE UNIVERSITY OF PENNSYLVANIA.

THE club met on Saturday, February 28, in the Randal Morgan Physical Laboratory and listened to a paper by Mr. Homer M. Derr, on 'Chromatic Interference with Thin Section of Doubly Refracting Crystals in Polarized Light.' The paper contained in brief the theory of the colors of thin rock sections as seen through a polarizing microscope and discussed the practicability of using the same as a means of analysis when chemical action was insufficient to detect certain minerals.

Mr. Derr is constructing a table of the colors up to the fourth order of different minerals with varying thicknesses for qualitative analysis in petrology.

At a meeting of the club on March 7, a paper was presented by Mr. J. Frank Meyer, which reviewed the history of electric convection from the beginning to its present culmination in the dispute between Cremieu and Prender. There was a full attendance at the meeting.

JOS. H. HART,
Secretary.

DISCUSSION AND CORRESPONDENCE.

WILL-MAKING.

TO THE EDITOR OF SCIENCE: Professor Chamberlain's suggestion in SCIENCE, March 6, page 391, that wills should be probated during the lifetime of the testator, has been frequently made to legislatures and just as frequently rejected. It was one of the matters considered and rejected by the judges' committee in the recent revision of Colorado probate law.

In the first place, the suggestion assumes that will disputes and the so-called 'breaking of wills' are matters of very common occurrence, which, though a popular supposition, is to those whose business is the administration of probate law known to be entirely incorrect. An attack upon a will is the exception, and a successful attack even vastly rarer. The few cases of rejected wills are published far and wide in the newspapers, while the thousands admitted to probate without contest never are heard of by the public, creating an erroneous impression. I have had personal knowledge of hundreds of wills, and while I have heard of such instances and read of them in the newspapers and judicial reports, yet have never personally known of refusal to admit a will to probate, except in a few cases in which the paper was not attested by the proper number of witnesses. During the last year I have been constantly in communication and conference with other judges having probate jurisdiction and with probate lawyers, and have found that to be the common experience. If men fail to have their wills witnessed by the statutory number of witnesses, they would be as apt to fail to probate them during lifetime, as it would be only another means of having them witnessed. Then, too, the tendency would be to discourage wills by making the process more complicated, and making it impossible in cases where the testator is far from court and physically unable to travel, or when death is imminent and time, therefore, limited. Furthermore, the question of its construction and effect could not be properly and safely determined by the court in a purely *ex parte* proceeding, and if it could, in many cases a decree thus drawn without a knowledge of the future would itself often come up for construction later on.

It is doubtful, in any case, whether it is advisable to override a fundamental principle of civilized jurisprudence, to wit, that 'every man should have his day in court.' Fraud would be much easier under such a system. While in a mental condition unfitting him to do business but not manifesting itself to the court on casual inspection, or under undue influence through fear or other causes, a man is brought by beneficiaries under his will before a probate court and his will admitted to probate. Then his life is taken by the beneficiaries. No matter what facts they might be able absolutely to prove, the mouths of his heirs, who have never had a chance to be heard, are closed. They can not attack the probate, so the will stands and the property goes where neither the law nor the testator wished it to go. On the whole, the suggestion seems a dangerous one. The Colorado probate revision committee considered the remedy suggested much more dangerous than the disease.

Junius Henderson.

CURRENT NOTES ON PHYSIOGRAPHY.

SNAKE RIVER LAVA PLAINS.

Russell's latest report on the 'Geology and Water Resources of the Snake River Plains of Idaho' (U. S. Geol. Survey, Bull. 199, 1902) is as full of physiographic matter as many of his earlier reports have been. The plains are in southern Idaho, measuring 350 miles in length by from 50 to 75 miles in width; they occupy a broad depression between enclosing mountains, and are built of extensive basaltic lava flows often overlying Tertiary 'lake beds.' The lavas have been ascribed to fissure eruptions, but Russell follows Lindgren in referring them to volcanic vents within the area of the plains or in the neighboring mountains. Several lava streams issue from the mountain valleys; one of them was so liquid when erupted that after flowing fully 50 miles as a stream from one to three miles wide it could still spread widely on the plains. The vents within the plains are either cinder cones of the ordinary type, from which very fresh flows are traceable, or low broad lava cones of gentle slope, 8 to 10 miles in basal diameter and only 200 or 300 feet high. The more liquid flows thin out gradually on the plains to feather edges; others are limited by ragged scarps 20 or 30 feet high. The border of the plains contours around the enclosing mountains, converting valleys into bays, spurs into headlands and outlying knobs into 'steptoes' (p. 34). The most remarkable examples of the latter forms are two dissected rhyolitic volcanoes, of which the highest, Big Butte, rises 2,350 feet over the plains. In one district of fresh flows, a road between two towns forty miles apart follows the slight depression between the edge of the lava and the mountain slope, turning into every valley and rounding every spur, and thus doubling the straight-line distance, rather than climb the hills or cross the bare lava. Most of the plains are covered with a soil largely æolian. Extensive gravel fans are formed where certain streams have had to aggrade their courses on passing from mountain valleys of strong slope to the level plains; here Russell unfortunately introduces the term 'upgrading streams' (p. 133), although he has used 'aggrading' in his 'Rivers of North America.' Some fans antedate the lavas and stretch under them, favoring the passage of ground water beneath the plains. Snake River and its larger branches trench the plain where it is lava-covered, and produce a mature topography in the unprotected lake beds further west. Special account is given of short canyons eroded by springs along the border of Snake River canyon.

THE FAN OF LANNEMEZAN.

The great fan or 'plateau' of Lannemezan, with a radius of more than 100 kilom., at the foot of the Pyrenees in southwestern France, together with its smaller neighbors on the west, the fans of Orignac and Ger, have long been noted for the unsymmetrical form of their radial consequent valleys, whose side slopes are with few exceptions steeper on the right than on the left of the stream. It has frequently been suggested that this systematically unsymmetrical habit might be due to the deflective force arising from the earth's rotation, and the suggestion has as often been doubted because the deflective force must be so small. A thorough study of the problem

by Marchand and Fabre ('Les érosions torrentielles et subaëriennes sur les plateaux des hautes Pyrénées,' *C.-R. du Congrès des Soc. Sci. en 1899*, Paris, 1900) indicates that the doubt is well founded and refers the asymmetrical form to the action of the northwesterly rain-bringing winds and the associated action of lateral rills and radial torrents on the weaker and stronger strata of the fans. A determining factor is found in a compact clayey layer at about mid-height on the valley side between weaker, sandier deposits below and above. So long as the valleys are worn only in the weak upper layer, their cross-section shows a gentle slope on the side *AB* that is attacked by the northwest winds. But when the valleys are worn through the resistant clays to the weak under layers, the lower slopes, *CD*, on the wind-attacked side

are steepened, although the earlier relation may still obtain on the higher slopes; and it is in this condition that most of the valleys are found. The explanation of the process by which this change of form is brought about is not immediately convincing and is too detailed for abstract here.

THE QUEENSLAND COAST.

A 'PRELIMINARY note on the Geology of the Queensland Coast * * *' of northeastern Australia, by E. C. Andrews (*Proc. Linnean Soc. N. S. W.*, 1902, pt. 2, pp. 145–185), presents in modern form—although not in the best arrangement—a highly appreciative account of the mainland and islands back of the Great Barrier reef. The terminology of Gulliver's essay on 'Shore line topography' is largely used. The continental shelf on whose outer edge the great reef is built at from fifteen to one hundred miles from the mainland is described a lowland and platform of subaerial and marine denudation and deposition, moderately submerged in Pleistocene time. The shelf continues south of the reef, its outer slope always rising from great depths. Numerous monadnock-like islands of continental rocks (granite, etc.), often rugged and mountainous, rise from the shelf as far out as twenty miles from the mainland. The islands and the mainland are commonly bordered with low, sandy coastal plains and mangrove swamps, up to twenty miles in breadth, exhibiting consequent drainage; and from this a slight modern elevation is inferred. Some of the islands are made of sand only, bearing high dunes. Many of the islands are tied together or to the mainland by tombolos, bays are more or less enclosed by bars, and rivers are deflected scores of miles northward by the growth of heavy sand reefs under the action of currents and waves driven by the southeast trade wind. The monadnocks increase in number on the mainland, until the highest part of the back country gains the appearance of an undulating tableland, up to 4,000 feet in altitude. This is described as showing late-mature Tertiary valleys eroded 1,000 feet or more beneath a Cretaceous peneplain, whose remnants are often capped with basalt outliers resting on auriferous gravels. About Pliocene time the whole country was uplifted so that cañons 3,000 feet or more in depth are now cut in the Tertiary valley floors; the streams plunge down falls 1,000 feet in height from the as-yet-uncut valley floors into the canyon heads. W. M. DAVIS.

RECENT ZOOPALEONTOLOGY.

COMPARISON OF THE EUROPEAN AND AMERICAN EOCENE HORSES.

A PAPER published in March, 1901, which should have been reviewed earlier is by Professor Charles Depéret, of Lyons, entitled 'Revision des Formes Européennes de la Famille des Hyracothéridés.' It consists of the study and redefinition of all the types of Eocene horses described during the last century in France and England before the ancestral relationship of any of these animals to the horses was appreciated. Since the recognition of the Eocene horses in America by Marsh, it has become evident that they are very closely allied, if not identical in stages of evolution with contemporary forms in Europe. As a result of a close analysis, which is accompan-

ied by admirable figures, Depéret points out that *Eohippus* Marsh from our Wasatch (p. 222) is closely similar to *Hyracotherium* Owen and to *Pachynolophus* Lemoine from the Suessonian; that *Protorohippus* Wortman from our Wind River is closely similar to *Propalæotherium* Gervais and *Pachynolophus* Pomel; that *Epihippus* and *Eohippus* Marsh are similar to *Lophiotherium* Gervais. It is probably premature to attempt to establish generic identity between these American and European forms; but it is evident that the time is not far distant when such identity is likely to be established, unless we take the ground that the European and American forms were entirely independent in their evolution from the time of their first appearance.

THE PALEONTOLOGICAL LITERATURE OF 1898 AND 1899.

Dr. Max Schlosser, of Munich, again places us in his debt by the continuation of his valuable résumé of the literature upon fossil and recent mammals.* This annual review began in 1884. The present section fills nearly one hundred pages of fine type, and the works reviewed are divided under three heads: (1) Those properly pertaining to Pleistocene anthropology and mammalian remains found with man; (2) the Tertiary and Mesozoic mammals; (3) the distribution and taxonomy of recent mammals. In the exhaustive library of the University of Munich, Dr. Schlosser finds practically the literature of the world, and in this review he gives a brief abstract of all that was published during the years 1898 and 1899. It is the author's custom to fairly present in abstract the works reviewed, including very brief critical remarks of his own. These digests are clear, and remarkably free from prejudice. They are simply priceless for every worker in mammalian paleontology and anthropology, and our thanks to Dr. Schlosser cannot be too heartily expressed.

H. F. O.

* 'Literaturbericht für Zoologie in Beziehung zur Anthropologie,' p. 115, für das Jahr 1898, p. 165 für das Jahr 1899.

SOME SINGULAR NICKEL-STEEL ALLOYS.

Through the courtesy of M. Ch.-Ed. Guillaume, Directeur-adjoint du Bureau international des poids et mesures, Paris, there has come to hand a very interesting collection of documents * relating to a curious variety of nickel-steel alloys, regarding which little seems to have been published on this side the Atlantic, and the only notice of which, according to the inventor, has been in the form of a denial of the possibility of their existence.

M. Guillaume has discovered, has produced in quantity and has brought into use in the industries, an alloy of steel or iron and nickel which he denominates 'non-dilatable'; it remains of substantially constant dimensions with ordinarily varying temperatures. This peculiarity, as he says, is allied to a general anomaly attributable to alloys of this class capable of forming solid solutions which are in certain cases unstable. Forthcoming publications in the French technical and scientific journals are expected to give later information regarding this curious series of alloys which are expected to have important applications in the arts. They are already in use in horological work and the pendulum of constant length may now be had. Instruments of precision, and particularly measuring apparatus for geodetic and other fine work, may be thus constructed.

These alloys are actually produced commercially, at Imphy, by the Société de Commentry-Fourchambault. They are now coming into use for many purposes in Europe, and should be better known in this country. The surveyor's tape, the measuring rod for

* 'Recherches sur les aciers au nickel,' Société d'Encouragement; Paris, 1898; 'Sur les variations temporaires et résiduelles des aciers au nickel réversibles,' *Comptes rendus*, i., CXXIV., 1897; 'Das Leben der Matérie,' *Physikalische Zeitschrift*, 2, 1899; 'Les déformations passagères des solides,' Cong. Int. de physique, 1900; 'Les aciers au nickel,' *ibidem*, 1900; 'Le pendule en acier au nickel,' *Journal Suisse d'horlogerie*, 1902; 'Magnetostriction des aciers-nickel,' *Journal de physique*, 1902; 'La convention du mètre et le Bureau international des poids et mesures,' *Bull. de la Soc. d'Encouragement*, 1902.

geodetic work* and the pendulum are among the first applications to find recognition, but the expectation of M. Guillaume is that it will prove possible to adapt other nickel-steel alloys for substitution for the filament of the common 'incandescent' lamp, a work in fact already in progress.

M. L. Dumas, in his 'Les aciers au nickel à haute teneur'† describes the mechanical properties of above one hundred and fifty of the alloys of these metals. At least one Paris firm, Radiguet et Massiot, on the rue Château-d'eau, has undertaken the marketing of these alloys.

These new discoveries and their outcome may not have as impressive aspects as those which have given us nickel-steel armor-plate or gun-barrels; they perhaps have more real importance to the world. The supply of nickel ores seems likely to prove ample for the immediate future, at least, and scientific men and engineers will be hopeful of still other and useful products in this field. Meantime, M. Guillaume deserves great credit and large returns for his part in the work of exploitation.

R. H. THURSTON.

* The recent measurement of the meridional arc on Spitzbergen was effected with this alloy in the measuring wires.

† Published by Dunod, Paris, 1900.

RADIUM.

SIR WILLIAM CROOKS has written to the London *Times* the following letter:

In the presence of a mystery like that of radium any reasonable attempt at explanation will be welcome, so I will ask your permission to revive a hypothesis I ventured to submit to the British Association in my presidential address in 1898. Speaking of the radio-active bodies then just discovered by M. and Mme. Curie, I drew attention to the large amount of energy locked up in the molecular motions of quiescent air at ordinary pressure and temperature, which, according to some calculations by Dr. Johnstone Stoney, amounts to about 140,000 foot pounds in each cubic yard of air; and I conjectured that radio-active bodies of high atomic weight might draw upon this store of energy in somewhat the same manner as Maxwell imagined when he invented his celebrated 'demons' to explain a similar problem. I said it was not difficult so to modify this hypothesis as to reduce it to the level of an inflexible law, and thus bring it within the ken of a philosopher in search of a new tool. I suggested that the atomic structure of radio-active bodies was such as to enable them to throw off the slow-moving molecules of the air with little exchange of energy, while the quick-moving missiles would be arrested, with their energy reduced and that of the target correspondingly increased. (A similar sifting of the swift-moving molecules is common enough, and is effected by liquids whenever they evaporate into free air.) The energy thus gained by the radio-active body would raise its temperature, while the surrounding air would get cooler. I suggested that the energy thus gained by the radio-active body was employed partly in dissociating some of the gaseous molecules (or in inducing some other condition which would have the effect of rendering the neighboring air a conductor of electricity) and partly in originating undulations through the ether, which, as they take their rise in phenomena so disconnected as the impacts of molecules, must furnish a large contingent of Stokesian pulses of short wave-length. The shortness in the case of these waves appears to approach, without attaining, the extreme shortness of ordinary Röntgen rays.

Although the fact of emission of heat by radium is in itself sufficiently remarkable, this heat is probably only a small portion of the energy radium is constantly sending into space. It is at the same time hurling off material particles which reveal their impact on a screen by luminous scintillations. Stop these by a glass or mica screen and torrents of Röntgen rays still pour out from a few milligrams of radium salt, in quantity to exhibit to a company all the phenomena of Röntgen rays, and with energy enough to produce a nasty blister on the flesh, if kept near it for an hour.

In conclusion, if it is not too much trespassing on your space, I should like to express the great admiration which I have, in com-

mon with all English men of science, for the brilliant discovery of radium, and its unique properties—the crowning point of the long and painstaking series of researches on radioactive bodies undertaken by Professor Curie and his talented coadjutor, Mme. Curie.

THE MARINE BIOLOGICAL LABORATORY OF THE U. S. FISH COMMISSION.

The Marine Biological Laboratory of the U. S. Fish Commission at Beaufort, North Carolina, will be opened to investigators on June 1, 1903, for a period of four months.

The laboratory is well equipped with glassware, reagents and running water, both salt and fresh, and is lighted with electricity. The apparatus needed for the collection of materials for investigation is furnished, and an experienced collector will assist in this work. A sailboat and steam launch are available for dredging, trawling and other collecting in the harbor and there is a prospect that facilities will be provided for deep-sea dredging and collecting in the Gulf Stream for a considerable time during this season.

Rooms and board for a limited number of men are furnished at about the cost of supplying the table and caring for the rooms. A well-trained and experienced cook will be in charge of the 'mess.' All water used on the table and for cooking comes from an artesian well driven on the island to a depth of 236 feet. Last season all expenses of living at the laboratory were covered by $5.25 per week and it is probable that this season they will be a little less.

It is well known that the marine fauna of Beaufort is very rich and that pelagic organisms are especially abundant. The climate is neither unpleasant nor unhealthful. The temperature rarely rises above 85° F., and there are few days when a sea breeze does not prevail. The atmosphere is humid, but fogs are almost unknown. With the water and diet provided at the laboratory mess there is no danger to health.

Beaufort is connected with Morehead City, the nearest railroad station, situated across the harbor, by a line of launches which stop at the laboratory wharf. The Atlantic and North Carolina Railroad connects at Goldsboro with the Southern and Atlantic Coast Line railroads. The laboratory may also be reached by an almost all water route via Norfolk, Elizabeth City and New Bern.

Those desiring to occupy tables in the laboratory should write for application blanks to Caswell Grave, Johns Hopkins University, Baltimore, until May 28. After that date to Beaufort, North Carolina.

MONOGRAPH OF NORTH AMERICAN MOSQUITOES.

Dr. L. O. Howard, of the U. S. Department of Agriculture, is engaged in arranging plans for an elaborate monograph of the mosquitoes of North and Central America and the West Indies under a grant from the Carnegie Institution. It is proposed to devote at least three years to the work, and to make the monograph as perfect as possible, both on the systematic and biological sides. The large collections of the U. S. National Museum and the Department of Agriculture will be used as a basis. Trained observers will be stationed at different points, the faunal regions being taken into consideration in choosing localities. Up to the present time the following localities and observers have been selected: Chicopee, Mass., Mr. Frederick Knab; Ithaca, N. Y., Mr. O. A. Johannsen; Minneapolis, Minn., Professor F. L. Washburn; Kaslo, B. C., Dr. H. G. Dyar; Stanford University, Cal., Professor V. L. Kellogg, or an assistant; Salt Lake City, Utah, Mr. R. V. Chamberlin; Victoria, Texas, Dr. W. E. Hinds; Baton Rouge, La., Professor H. A. Morgan; Clemson College, S. C., Professor C. E. Chambliss; Havana, Cuba, Mr. J. R. Taylor; Guanajuato, Mexico, Dr. Alfredo Dugès. Additional localities and observers will be selected later. Dr. Howard will be assisted in the systematic work on the adults by Mr. D. W. Coquillett, of the National Museum, and on the larvæ, by Dr. H. G. Dyar, also of the National Museum, since both of these observers are skilled in these subjects.

Volunteer observers are greatly needed, and it is Dr. Howard's hope that persons interested in this subject, and especially those resident

in the Gulf states and in Central America, will correspond with him and send him material. Investigators already engaged in mosquito work, like Dr. John B. Smith, of Rutgers College, and Professor Glenn W. Herrick, of the Mississippi Agricultural College, will cooperate, it is hoped.

SCIENTIFIC NOTES AND NEWS.

THE University of London will, on June 24, confer the honorary degree of Doctor of Science on Lord Kelvin and on Lord Lister.

PROFESSOR THEODORE BOVERI, of the University of Würzburg, and Professor W. M. Wheeler, who has recently accepted a call from the University of Texas to the American Museum of Natural History, have been elected correspondents of the Philadelphia Academy of Natural Science.

THE Donohoe comet-medals of the Astronomical Society of the Pacific have been awarded to M. Michel Giacobini, astronomer, Nice, France, for his discoveries of unexpected comets on December 2, 1902, and January 15, 1903.

DR. OSKAR UHLWORM, director of the German bureau of the International Catalogue of Scientific Literature, has been given the title of professor.

REAR-ADMIRAL J. G. WALKER, General P. C. Hains, Major William M. Black and Professor William H. Burr, the members of the American commission which is to make an inspection of the Panama Canal route, have arrived at the Isthmus.

AMONG the American physicians who have gone to Madrid to attend the International Medical Congress are Dr. Abraham Jacobi, of New York City; Dr. Nicholas Senn, of Chicago; Dr. Howard Kelly, of Baltimore; and Surgeon-General R. S. Reilly, U.S.A.

PROFESSOR L. G. CARPENTER, of the department of Civil and Irrigation Engineering of Colorado Agricultural College, has been granted a temporary leave of absence in order to act as state engineer of Colorado, which includes lines of work much the same as have been carried on in connection with the work of the experiment station. In the meantime Professor Carpenter will retain his connection with the experiment station and have supervisory control of the Department of Civil and Irrigation Engineering at the college.

MR. J. W. BAIRD, Ph.D. (Cornell), has been appointed by the trustees of the Carnegie Institution to a research assistantship in psychology with Professor Titchener for the academic year 1903–4.

A PORTRAIT of Dr. Richard Caton, the first professor of physiology in University College, Liverpool, has been presented to the college.

PLANS are being made to erect a monument to the philosopher Kant in Berlin, to be unveiled on the occasion of the hundredth anniversary of his death, in 1904.

DR. ALBERT HUNTINGTON CHESTER, professor of chemistry and mineralogy at Rutgers College, died on April 13, at the age of sixty years. He graduated from the Columbia School of Mines in 1868 and later took the degree of Doctor of Philosophy from the same institution. Before going to Rutgers College in 1891, he was for twenty-one years professor at Hamilton College.

DR. G. A. RUNGE, assistant director of the Meteorological Institute at Copenhagen, died on March 28.

WE learn from Professor George E. Hale that Miss Helen E. Snow, of Chicago, has provided for the reconstruction of the coelostat reflecting telescope of the Yerkes Observatory as a memorial to her father, the late George W. Snow. The telescope will be provided with solar and stellar spectrographs, spectroheliographs and other important accessories. It will be remembered that the coelostat reflector which the new telescope is to replace was seriously injured by fire last December, giving rise to erroneous but widespread statements that the main building of the Yerkes Observatory, as well as the 40-inch refractor, had been destroyed.

THE directors of the Benjamin Apthorp Gould fund have appropriated the sum of $400 in aid of the determinations of stellar parallax, in progress at the Washburn Observatory.

The board of aldermen of New York City have voted $75,000 for the New York Zoological Society for the erection of a new ostrich house and for quarters for the mammals.

At the session of the legislature of the state of New Jersey, which has just ended, provision was made to carry out the law passed the year previously, which authorized an investigation into the habits of the mosquitoes infesting the state, and experiments looking towards their destruction. An appropriation of nine thousand dollars was made, of which five thousand is available during the current season and four thousand during the season of 1904. The investigation is placed in charge of the State Experiment Station, and Professor John B. Smith has been appointed to make it. Active field work is already in progress and much has been learned concerning the early habits of some of the species infesting marsh lands. It is intended to devote most of the time during the present year to the coastal areas and to the outskirts of the larger cities.

Mr. Andrew Carnegie has offered Cleveland $250,000 for the establishment of seven branch libraries, providing the city gives the sites and an annual appropriation of $25,000 a year. The library board has accepted the offer.

Two research studentships, of the value of £150 a year each—one in physics and one in biology—will be awarded this year by the Royal Society. Applications are to be made by June 1 to the assistant secretary of the Royal Society, Burlington House, London, W.

The Danish parliament has appropriated $1,000,000 for new buildings for the Medical School and Hospital of the University of Copenhagen.

Reuter's Agency is informed that Dr. T. Rubin, of Upsala, the leader of the scientific expedition which has been despatched to Africa by the British South Africa Company, has left England. He was accompanied by Dr. Stoehr, the medical officer. After conferring with Sir David Gill, the astronomer-royal at Cape Town, Dr. Rubin and the other members of the expedition, who will join him in South Africa, will leave for Chinde *en route* for Fort Jameson. He will then confer with the administrator of Northeast Rhodesia, and at once proceed to the work of the geodetic survey.

Four members of the German Antarctic expedition, which left Germany in August, 1901, have arrived at Sydney, N. S. W., from Kerguelen Island, where during eighteen months this detached party, under the leadership of Dr. Werth, pursued its investigations.

The marine laboratory of the Zoological Department of the University of California which has been located at San Pedro, California, during the past two years, will be moved to San Diego for the next year. The investigations carried on during the coming year by the laboratory will be chiefly on the plankton of San Diego Bay and the adjacent waters. Funds for carrying on the work of the station are furnished by the chamber of commerce of San Diego.

A new botanical and horticultural laboratory which has been established by the Royal Botanic Society in connection with its school in Regent's Park was opened on April 1. The building, which has been fitted up, will accommodate about thirty students.

We learn from the London *Times* that the program of the annual meeting of the Iron and Steel Institute of Great Britain (to be held at Westminster on May 7 and 8) promises to be more than usually interesting. Mr. Andrew Carnegie's inaugural address will deal with the great organizations of capital and labor in the world, and particularly with reference to American industrial problems. Mr. Carnegie will also present Sir James Kitson, M.P., with the Bessemer gold medal for his services to the iron and steel industries of Great Britain. The work of the research scholars endowed by Mr. Carnegie will also be submitted. The following papers will be read: Mr. Talbot, of Leeds, will give the results obtained by making steel from a 200-ton furnace by a continuous process; Mr. Keller, of Paris, will describe the successful manufacture of steel in the electric furnace; and C. von Schwarz, of Liége, will show how blast furnace slag

can be made into Portland cement; Mr. C. Mercader, of the Carnegie Works at Pittsburgh, will for the first time in public describe the plant for manufacturing hollow pressed axles for railroads.

The subject for the Adams prize of Cambridge University, open to all persons who have at any time been admitted to a degree, is: "Wave motion of finite amplitude and unchanging type, in deep water. Hitherto only one type of such motion has been discovered, that of Gerstner and Rankine, which involves vorticity; it is suggested that on examination this might be found to be a special case of a more general solution. No exact solution has hitherto been obtained in which the motion is irrotational; it is desirable that the question should be examined whether the known approximate solution is in fact an approximation to a permanent state of motion. In default of a conclusive answer to the above questions, any considerable advance in the theory of the subject, apart from an extension of the known approximations, is desirable." The successful candidate will receive about £225. The essays must be sent to the vice-chancellor on or before December 16, 1904.

In accordance with the provisions of the charter, the by-laws of the British Academy have been allowed by the Privy Council. The by-laws regulate the number of fellows, the council, sectional committees, general meetings, election of fellows and preliminary arrangements. The number of ordinary fellows is fixed at one hundred as a maximum limit, but it shall not be necessary to complete that number. The International Association of Academies has unanimously agreed to the admission of the association as a constituent academy in the philosophico-historic section. Lord Reay (president of the academy) has been nominated by the academy as a member of the International Council. Mr. Bryce, Sir R. C. Jebb and Professor Pelham have been appointed to represent the academy at the forthcoming International Congress of Historical Studies, to be held in Rome. The fellows of the academy are distributed under four main sectonal committees, each section having its own chairman: (1) History and Archeology, chairman, Mr. Bryce; (2) Philology, chairman, Sir R. C. Jebb; (3) Philosophy, chairman, Dr. Edward Caird; (4) Jurisprudence and Economics, chairman, Sir C. P. Ilbert.

The International Agricultural Congress was inaugurated at Rome on April 13 in the presence of King Victor Emmanuel and Queen Helena. About 1,300 delegates were present. The American representatives are Dr. Daniel E. Salmon, chief of the United States Bureau of Animal Industry, and Henry E. Alvord, chief of the Dairy Division of that bureau.

A Universal Exposition of Sciences, Arts and Industries will be held at Liége, Belgium, in the year 1905.

The American Electrochemical Society held its third general meeting in New York, on April 16 to 18.

The Spokane Science Club, of Spokane, Wash., held a meeting on March 10, at which papers were read by Mr. J. Y. McMullen, on DeVries' mutation theory and Mendel's law and by Mr. E. Channing Moore on the hydrocarbons. The correspondent who sends us this information calls attention to the value of such local clubs for scientific study and urges their establishment wherever possible.

On May 6 there will be civil service examinations for the positions of assayer in the Mint Bureau, Treasury Department, at a salary of \$2,200; for the position of editorial clerk in the Geological Survey at a salary of \$1,500, and for the position of clerk in nutrition investigations, Office of Experiment Stations, Department of Agriculture, at a salary of from \$720 to \$1,000. On May 26 and 27 there will be an examination for the position of forest draftsman in the Bureau of Forestry, Department of Agriculture, at a salary of \$900.

Messrs. Charles Scribner's Sons announce that they have arranged for the publication of a 'Library of Historical Psychology,' under the editorial supervision of Professor James Mark Baldwin, LL.D., of Princeton Univer-

sity. The library is to comprise a series of volumes on the history of the various topics of psychological thought from the earliest times, each volume being an independent work, but the whole constituting an encyclopedic 'History of Psychology'—a work never adequately carried out in any language. The arrangements for the volumes of the library—of which there will be twelve or more—are now being perfected, and the publishers expect to make early announcement of certain of the titles, names of writers, etc.

The following are the spring lecture arrangements at the Royal Institution: Professor Allan Macfadyen, three lectures on the blood and some of its problems; Professor G. H. Darwin, two lectures on the astronomical influence of the tides (the Tyndall lectures); Professor E. J. Garwood, two lectures on the work of ice as a geological agent; Professor Dewar, three lectures on hydrogen: gaseous, liquid and solid; Professor S. H. Vines, two lectures on proteid-digestion in plants; Professor J. A. Fleming, two lectures on electric resonance and wireless telegraphy; Professor Langton Douglas, two lectures on the early art of Siena; Mr. Hamish MacCunn, two lectures on music (with musical illustrations); and Professor Silvanus P. Thompson, two lectures on the De Magnete and its author, (1) the book, (2) the man. The Friday evening meetings will be resumed on April 24, when a discourse will be given by the Hon. R. J. Strutt on some recent investigations on electrical conduction. Succeeding discourses will probably be given by Professor William J. Pope, Mr. Rider Haggard, Dr. D. H. Scott, Dr. J. A. H. Murray, the Prince of Monaco and others.

UNIVERSITY AND EDUCATIONAL NEWS.

It is now officially announced that Mrs. Elizabeth Milbank Anderson gave on April 17, $1,000,000 to Barnard College, Columbia University, to purchase the three blocks of land adjoining Columbia College on the south and Barnard College on the west. Mr. Joseph Pullitzer has given $15,000 for scholarships to the university.

Mr. Andrew Carnegie has given $250,000 for an extension of the Mechanics and Tradesmen's Institute, New York City.

Dr. D. K. Pearsons, of Chicago, celebrated his eighty-third birthday on April 14, by making anniversary gifts to two colleges, Winter Park, Florida, $50,000 and Kingfisher College, Oklahoma, $25,000.

The Colorado Agricultural College will soon erect a building for the Department of Civil and Irrigation Engineering. This building will include also the offices of the Experiment Station during 1903–4. An appropriation of $40,000 has been made by the Colorado State Legislature.

Mr. John D. Rockefeller has offered to pay two thirds of the cost of a building for the University of Nebraska to be used for social and religious purposes, on condition that the remaining third of the $100,000 be contributed within about a year.

Mrs. Helen F. Ackley has left to Wesleyan University a bequest of $2,000, the income from which is to be used for the benefit of one or more women students; if at any time the trustees of the college refuse to accord women the same privileges in the university as the men, the fund is to revert to the residuary legatee.

The will of A. C. Hutchinson, leaving a large sum to the Medical Department of Tulane University, has been sustained by the courts.

Professor Elmer E. Brown, head of the Department of Education at the University of California, has been elected dean of the School of Pedagogy at New York University.

Mr. Joel Stebbins, fellow in the Lick Observatory, University of California, has been appointed instructor in astronomy, University of Illinois, and officer in charge of the observatory.

Mr. G. F. Stout, Wilde reader in mental philosophy at Oxford University and editor of *Mind,* has been elected to the chair of philosophy and metaphysics at the University of St. Andrews, vacant by the death of Professor Ritchie.